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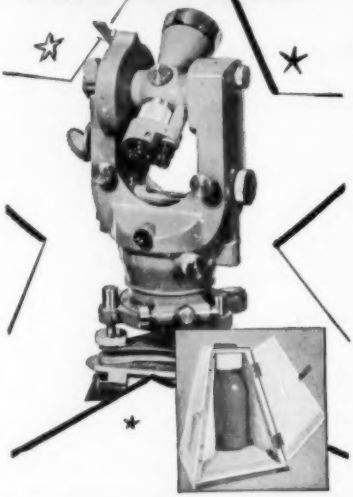

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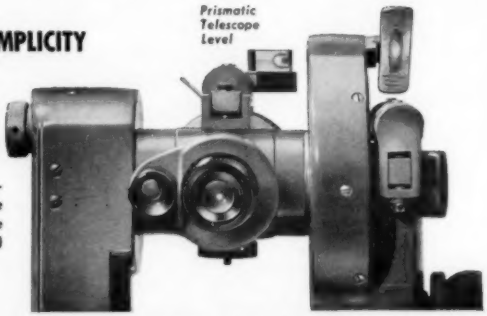

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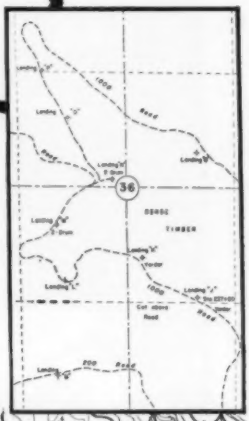

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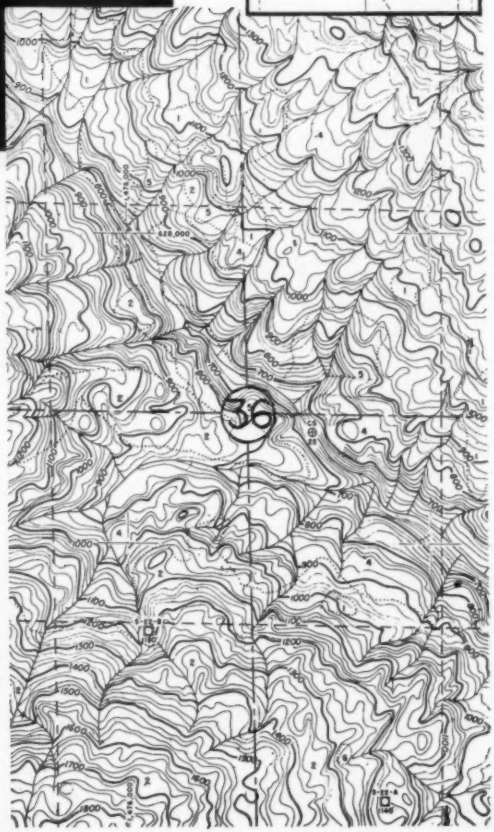

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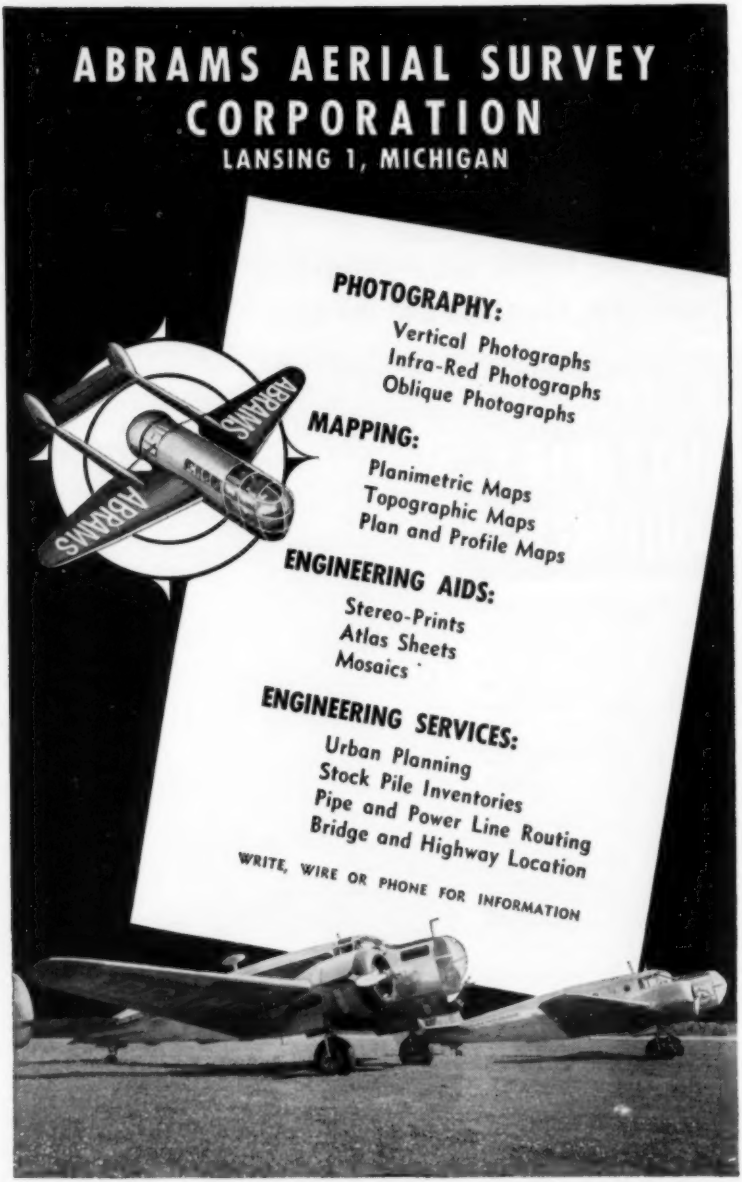
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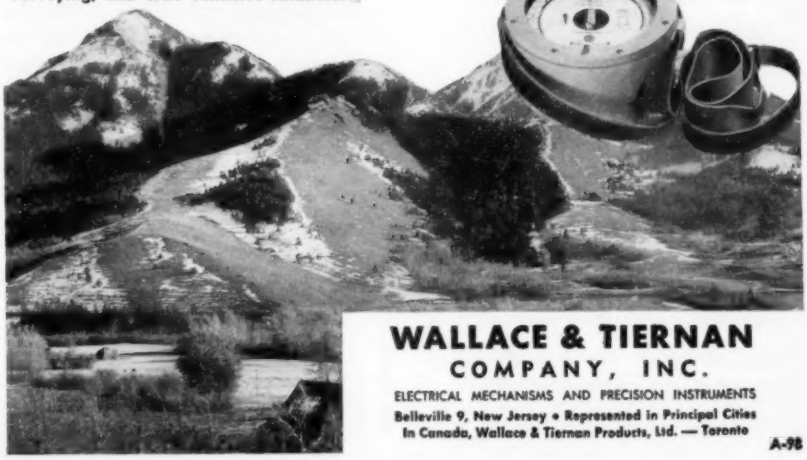

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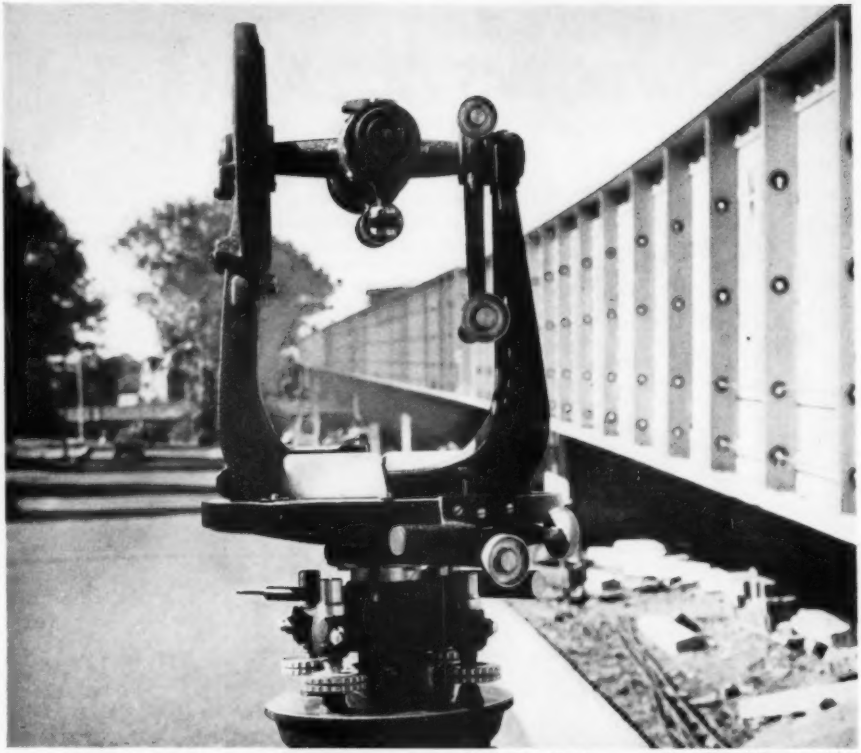

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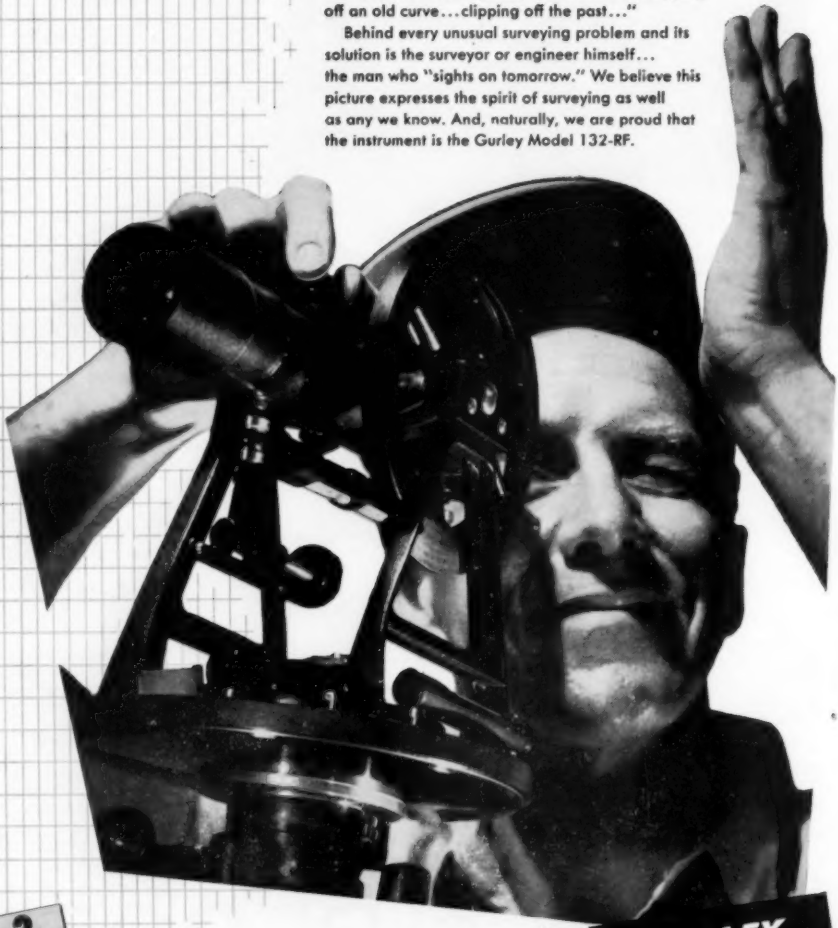

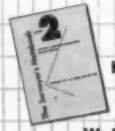

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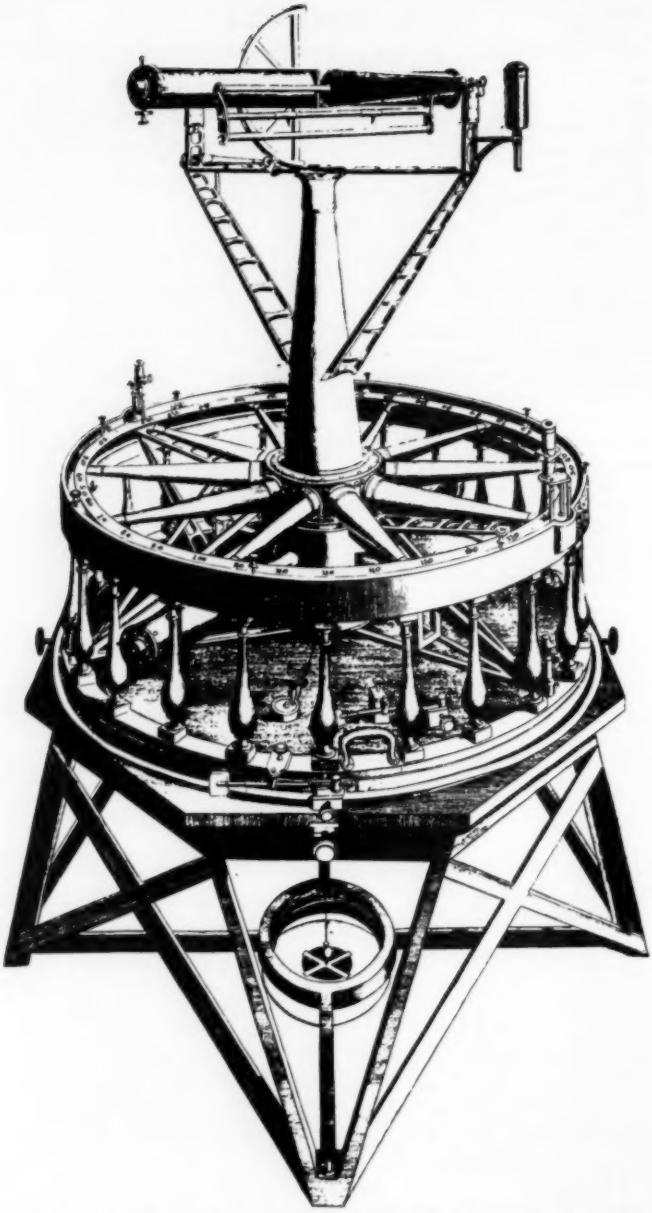


Jesse Ramsden's theodolite, built for the Royal Society, made possible the first accurate triangulation of England. (From *The Story of Maps* by Lloyd A. Brown. *See* "Maps—A Necessary Medium to World Progress," on opposite page.)

Maps—A Necessary Medium to World Progress

By LLOYD A. BROWN

LIBRARIAN, PEABODY INSTITUTE, BALTIMORE, MARYLAND

THE HISTORY of maps and map making is the record of man's attempt to understand the world he lives in: its size and shape, its movements, and its adaptability to the needs of the human race. It is the story of daring exploration and ruthless exploitation, of endless struggle and conquest, man against man, and man against the elements of distance, direction, and time. It is the history of an ancient art which grew to be a science.

In its present state of near perfection, the modern map or chart is often mistaken for one of the logical by-products of twentieth century technology, a scientific achievement that would have been quite impossible prior to this age. Nothing could be farther from the truth, for, even though map making evolved slowly and painfully, by trial and error, from remote beginnings, every essential element and problem of scientific cartography was thoroughly appreciated and understood by the great minds of antiquity. In fact, the modern map is little more than a triumph of coordination, a happy combination of land surveying, mathematics, and astronomy—ancient principles which have been skillfully brought together to fill a modern need. This merger of what the layman might consider unrelated knowledge has been in progress for at least 5,000 years, and is still in progress.

A MEDIUM TO PROGRESS

Yet, in spite of the technical accomplishments of modern cartography, I sometimes wonder if modern man appreciates as fully as his progenitors of two or three thousand years ago the significance of The Map as a medium to world progress, as well as a tool with which the world's business is conducted. The most obvious facts of life are the ones most easily overlooked or readily forgotten!

The development of cartography has occupied the minds of the greatest philosophers and scientists of all ages—and why? Because from the very beginning these men recognized The Map as the blueprint of conquest, the way to wealth. The Map has shown men where to go, how to go, and what they would find when they got there. It has proved to be the key to plenty and poverty in man's eternal struggle for the land ("Theatre of human endeavor")—who shall possess it and how it can best be exploited, for no nation has ever accomplished very much, either politically or economically, without a knowledge of its own backyard; and certainly no political power could seriously entertain dreams of empire without knowing in advance something about the size, shape, and desirability of its *neighbors'* backyard.

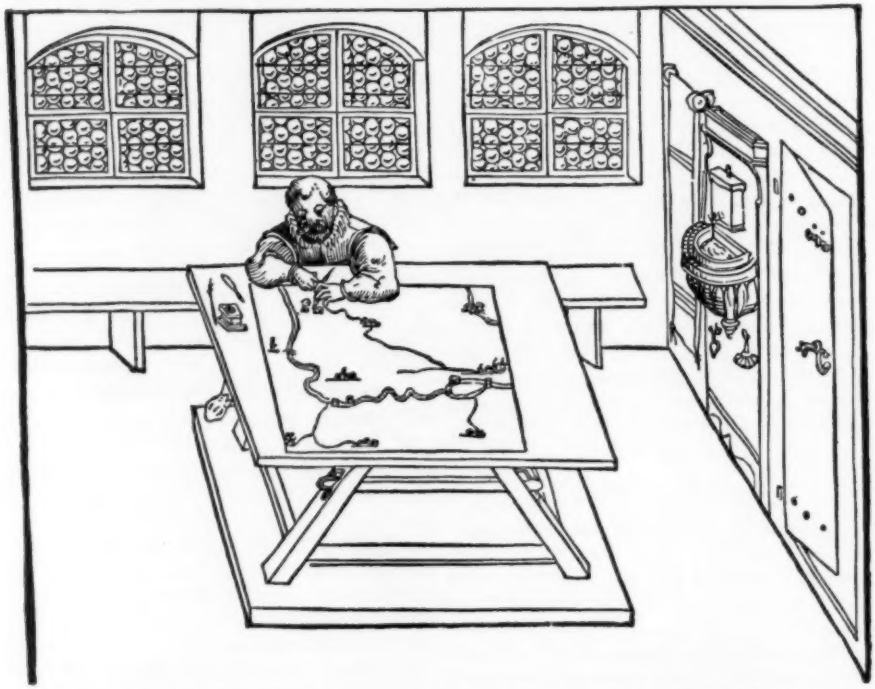
AN INDEX OF PROGRESS

The Map is not only a *medium* to world progress; it is a pretty fair *index* of progress as well. The rise of many a nation has coincided with the vigorous development of its cartographic resources; so much so, in fact, that it is a great temptation to draw sweeping conclusions in this connection. Disregarding the elements of cause and effect, history shows that cartography has been ranked high by the empire-building nations of the world. At the height of its power, the Roman Empire boasted a complete series of maps of its land holdings, its lines of communication, and for all we know it may have compiled a cartographic picture of its natural resources, as well as its long-range scheme of land utilization. Don't think for one minute that the Romans were

Presented at the Thirteenth Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., March 23–25, 1953.

ignorant of maps and charts, or that their efforts in the field of cartography were primitive.

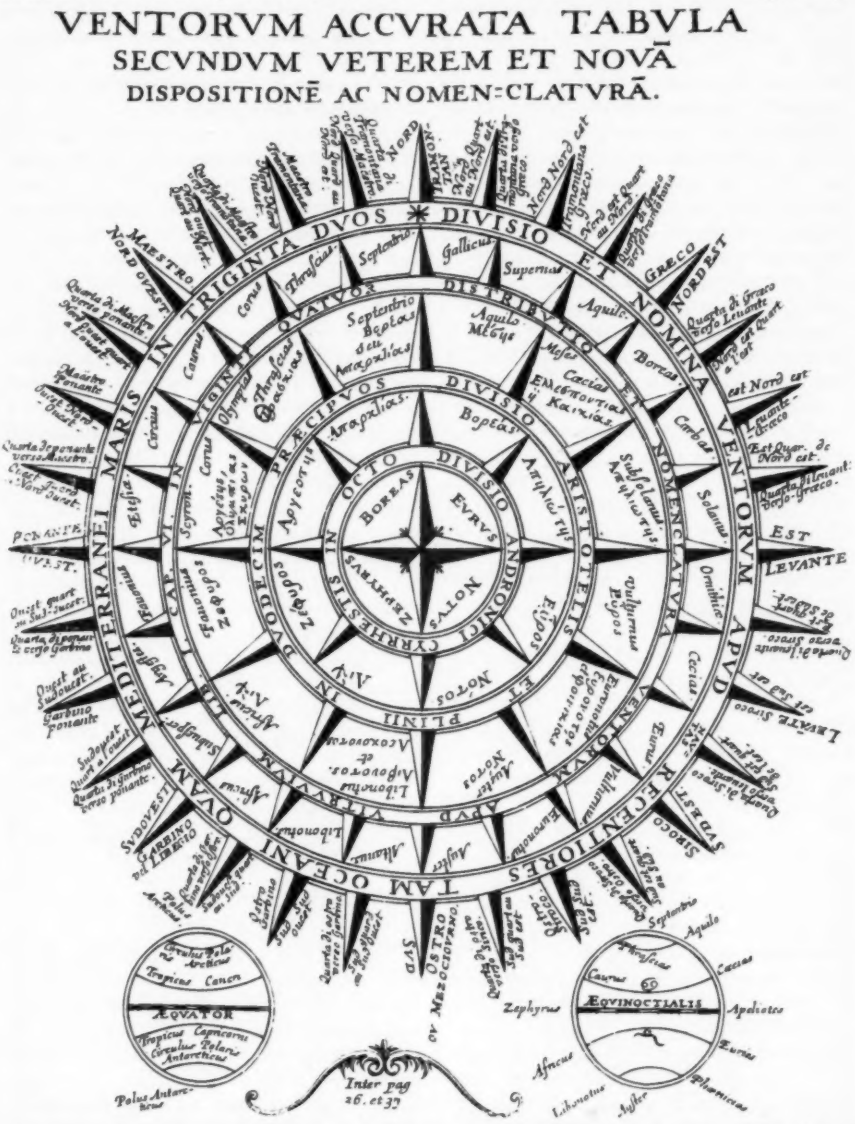
The same is true of Spain and Portugal during the period of exploration, except that those two powers were burgeoning maritime nations, more interested in accurate sailing charts than they were in the development of maps. To that end Spain organized, as early as 1503, the Casa de la Contratación de las Indias. The Casa, as it was later called, functioned as a combination Board of Trade and Hydrographic Office. In Spain foreign trade was practically synonymous with the art of navigation and the compilation of charts, and the Casa directed all such activities. Veitia Linaje, a contemporary historian, wrote that its jurisdiction was as large as its territory was boundless. Its authority was so extraordinary that it supplied the place of a Grand Council. By decree of August 8, 1508, the Casa set up a separate geographic or cosmographic department, probably the first Hydrographic Office in history. One of its chief functions was to organize, under a supervisory *junta,* the charting of the New World. To this end a master chart (*Padron Real*) was begun under the supervision of a commission of pilots. One of its first directors, its Pilot Major, was Amerigo Vespucci. The importance of the Casa, its Hydrographic Office, and its master chart, cannot be overestimated. No political intrigue, no alliance, holy or otherwise, no invasion of foreign soil, could be carried out without the master chart to guide the politician and the military man. Naturally the other nations of Europe showed more than a passive interest in the evolution of the



The earliest woodcut picture of a cartographer at work. From Paul Pfintzing's *Methodus Geometrica,* Nurnberg, 1598. (From *The Story of Maps* by Lloyd A. Brown.)

Padron Real, and for many years a genuine Spanish chart, presumably based on secret information known only to members of the Casa and their pilots, was considered a prize worth far more than its weight in gold.

Another indicator of maritime supremacy



A seventeenth-century composite wind rose showing the evolution of direction from Homer's four-wind rose to the 32-point card found on modern compasses. (From *The Story of Maps* by Lloyd A. Brown.)

and an expanding sphere of influence was the development of charts and coast pilots in the Netherlands during the 16th and 17th centuries. Holland and Belgium made them, and the rest of the world bought or stole them. Plagiarism of a good map or chart was practically a foregone conclusion the minute it came off the press. Occasionally it was possible to bribe the engraver before the plate was made, thereby scooping the author as well as the publisher. Of course, this procedure was commendable only if you happened to be on the receiving end of the deal.

If we look into the cartographic achievements of France during the 17th century, what do we find? In the background is the most opulent court of Europe and the most extravagant. And back of the throne of Louis XIV we find Jean Colbert, a clever minister who insisted that France could not dominate Europe without better maps, and that better maps would not be forthcoming until the nation could assemble a body of scientists close to the throne, men with the know-how and ingenuity to solve, among other things, the eternal and infernal problem of finding the longitude, both on land and at sea. Colbert was able to sell this idea to his monarch, and in 1667 the Académie Royale des Sciences (now the Institut de France) was founded. First, and always foremost, on the agenda of that great scientific organization was the improvement of maps and charts—by order of Jean Colbert and His Majesty, Louis XIV. What the Institut did in the next 25 years was to revolutionize cartography and to make absolutely worthless nearly all the maps and charts that had been made up to that time. That France did not remain pre-eminent in world politics as well as science, was no fault of the members of the Institut de France or their great contributions to cartography.

England, of course, was far from backward in her pursuit of empire and the cartographic aids with which to extend her trade routes. And like France, Britain expanded as her cartographic methods improved and her map resources increased. Again, I say it is a great temptation to draw sweeping conclusions, but regardless of cause and effect it can be said that the phenomenal growth of the British Empire in the 18th century would have been greatly retarded had it not been for the great strides made in cartography by the English scientists of that period.

After getting off to a relatively slow start, England fast made herself felt in the world of maps while her merchant-adventurers sailed the seas, planting the British flag and surveying irons in far-flung corners of the world. While her armies and the navy fought for and won new colonies, her engineers and scientists struggled mightily to produce better maps and charts and better equipment to make them with. In the latter part of the 18th century she developed a marine chronometer which would give a navigator his longitude within 1¼ nautical miles instead of the former 20. She developed a theodolite that would measure seconds of arc, a precision instrument of the finest workmanship, second to none. She produced the Drummond Light, a sharp and powerful beam that solved a knotty surveying problem—how to make accurate observations over long distances in murky weather. Then came the Ordnance Survey, a model that the rest of the world was glad to follow; and in the latter part of the century the Hydrographic Office, organized as a department of the Admiralty, which began life with one hydrographer, one assistant, and one draughtsman. Britannia then ruled the waves and a good share of *terra firma* as well.

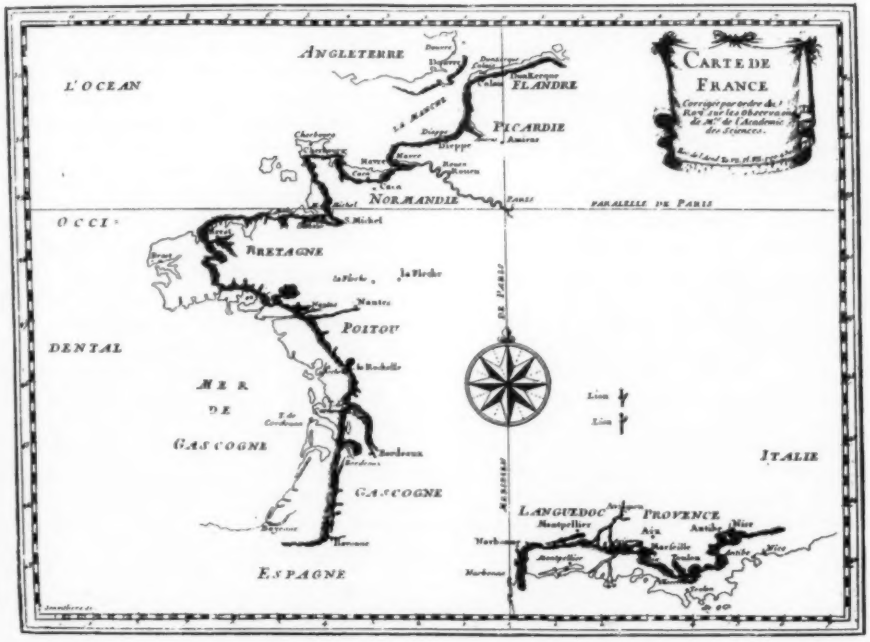
THE STATE OF MAPPING IN THE UNITED STATES

Now if, as I maintain, The Map is an *index* of, as well as a *medium* of progress, the logical conclusion of this brief historical sketch would be a summary tracing for you the pre-eminence of the United States in the world of maps as of this date, and pointing with pride to our vast and flourishing counterpart of Britain's Ordnance Survey. But this, as you can guess, is not to be, for good, if not sufficient, reasons.

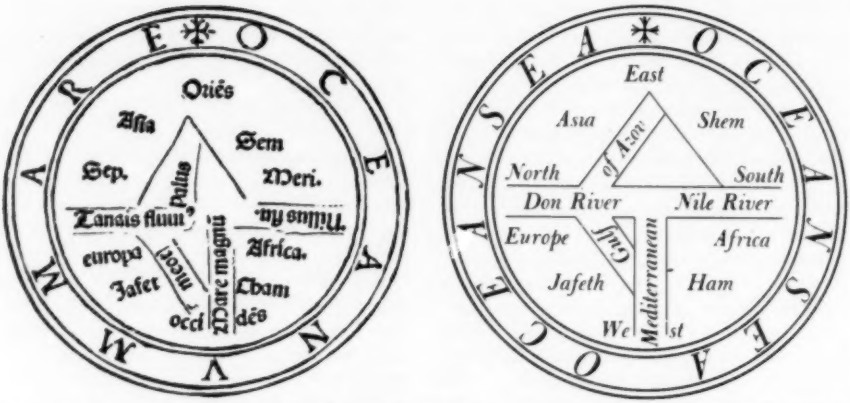
However, my theme is not to criticize the present state of mapping in the United States, but to point out a few of the not-so-obvious reasons why my country, the greatest nation on earth, has not caught up with the rest of the enlightened world in compiling a self-portrait that is sufficiently accurate and detailed to meet the requirements of every private citizen as well as the various civil and military agencies concerned with the efficient utilization of the land we live in. And my reasons for choosing this theme are no more or less than those expressed by Major General William Roy, when he tried to launch Britain's Ordnance Survey in the 18th Century. The honor of his country was concerned, he said, "in having at least as good a map of this, as there is of any other country. Compared with the greatness of the object," he wrote, "the annual expense to the public would be a mere trifle not worthy of being mentioned." I have not the slightest doubt that you share with me the General's sentiments in this regard.

A LOOK AT THE PAST

In order to understand our present situation we must take a long look at the past. From the time Columbus made his first landfall in the New World, the history of the Western Hemisphere has been the record of a mammoth land grab, with the participants often in the dark about what they were grabbing and how it was bounded. The speed with which the New World was explored and settled was something the like of which the Old World had never seen or dreamed about, and the men who took on the responsibility of mapping as they explored were unable to cope with the situation. The result, over a period of 400 years,



The resurvey of France under Cassini and Picard resulted in the above improved profile (*shaded*). (From *The Story of Maps* by Lloyd A. Brown.)



The world of Isidore, Bishop of Serville (570–636 A.D.) was extremely simple. The T-O map at left, from his *Etymologies*, is explained by diagram at right. (From *The Story of Maps* by Lloyd A. Brown.)

has been an urgency that has never once abated. The maps have never caught up with the expansion of the country.

For a long time North America was no-man's land, or rather anybody's land for the taking. Then, gradually, one by one the powers of Europe began to penetrate the interior, staking out claims and daring other powers to contest them. Many maps were made, but they were rather crude, disjointed affairs, and they were definitely not for public consumption. They were made by Spanish, Portuguese, French, English, German, Polish, Swedish, and Swiss cartographers, to mention a few, and each map varied in detail and accuracy according to the standards and training of the man who made it. The only thing these surveys had in common was the territory they were supposed to portray. Place names varied with the language and fancy of the individual. Each map and chart had its own system of linear measure, often based on some ancient and venerated units that had little, if anything, to recommend them. The net result of all this confusion was that up to the year 1700 there were no surveys of any large part of North America worthy of the name, and scientific observations were the exception rather than the rule. Royal grants that generously included all land lying between two parallels and which extended from the Atlantic Ocean to the Pacific meant nothing, because no human knew, within many miles, where these parallels were; and, of course, no one had come even close to measuring the distance between the two oceans. Boundary lines either followed rivers, because rivers were visible to everyone and unmistakable, or they were marked by blazes on trees or by rock piles that were easily moved or abolished. Possession was ten points of the law instead of nine, and a stockade, solidly built and heavily manned, was a far better title to a tract of land than any deed written on paper or parchment.

In the 18th century things took a turn for the better. Cartography was put on a scientific basis, chiefly by the Institut de France and England's Royal Society. The remapping of Europe during that period amounted to a pilot operation wherein new methods and new apparatus were tested before they were brought to the vast proving ground of North America.

By the time the Revolutionary War broke out in 1776, both France and England were vigorously engaged in mapping the colonies and provinces of North America. The British were doing it systematically as far inland as they dared claim, and both

nations were busy mapping the coasts and harbors of Colonial America. Both were engraving and publishing large-scale charts while the Revolutionary War was in progress.

The definitive treaty of peace signed and sealed in 1783 established for the first time the boundaries of the United States, and the best available map to show those boundaries was a large-scale map of the British Dominions in North America published 28 years before the treaty was signed, and needless to say, it was woefully inadequate. However, that map constitutes our title deed to the United States. On that map, compiled from the most reliable sources, are many place names that would be difficult to identify today, and in the treaty itself are names of reputed places which had not been specifically located on the ground. The cost of merely locating and properly identifying those places—a long, tedious process—has run into millions of dollars over the course of years.

WHY MAP THE WILDERNESS?

Now we come to a curious paradox in the mapping of the United States. Although there has always been an atmosphere of urgency connected with our scattered mapping projects, especially among our military leaders from George Washington to Omar Bradley, at the same time, our people have felt that the United States, from ocean to ocean, contained more land than any country would ever use, millions of square miles that would never be needed for any purpose whatsoever. Those were the days when acres of virgin timber, hardwood at that, were burned to clear land so that it would produce corn, wheat, or just grass. The coasts were important, and therefore pretty well mapped, but the wilderness of the plains and the Rockies had little to offer civilized people except desolation, starvation, and hostile Indians.

The discovery of gold in California changed all that, and in 1849, only a short century ago, the entire country found itself in a most embarrassing situation. The only available maps of the overland route to the gold fields at the other end of the country were little "Tourists' Guides" with small folding maps that were usually overoptimistic in the information they purveyed, and woefully short on detail. They made the old Santa Fe Trail look like a four-lane highway and the whole journey like a Sunday school picnic. But such was the lust for gold that people took almost anything in the form of a map and started for California without delay. The West and ways to get there had not been well mapped; there had been no urgent need for careful surveys of the interior up to that time, and all the existing maps of the United States were full of errors; in fact, vast areas of the country were virtually unknown to white men. Rather than brave the wilderness of the United States, many of the gold hunters took one of two alternate routes. The first, across Mexico, began at Vera Cruz; from there one went from San Blas to Acapulco on the Pacific coast. This was the short way, only about 60 days, but all those who took the route across Mexico were advised to go in parties of not less than 50, because the chances of being massacred by bandits were excellent.

The other choice was to go by sea, a nice restful voyage down around Cape Horn in the teeth of the filthiest weather known to man. It was an 18,000-mile voyage, and if you made it at all it might take as long as 5 months to get to San Francisco Bay, where your captain had to improvise, because there were no charts of the harbor. But, in spite of these inconveniences and hazards, the ships were crowded, and more than one skipper sailed out of New York harbor with nothing better than an elementary school atlas to guide him around the Horn and up the west coast.

Government support of a national mapping project in the United States was slow in coming, for reasons I have already mentioned. There was just more land than people knew what to do with, and a good map of the country could wait. Besides it would cost a lot, and taxes would inevitably go up. Lacking the incentive of European countries to keep abreast of belligerent

neighbors and defend their boundaries, the loosely united Federal government, composed of delegates from widely scattered areas, failed to see the strategic importance of mapping the new country as a whole. The Coast Survey (now the Coast and Geodetic Survey) was first proposed by Thomas Jefferson and authorized by Congress in 1807, but 36 years went by before it was given a stable organization and funds with which to function.

The Geological Survey emerged as recently as 1879, having evolved from a long series of temporary organizations, and this agency was immediately handed the colossal task of coordinating the mapping activities of the country, classifying the vast public lands, and at long last, "examining the geological structure and mineral resources of the national domain"—just about a hundred years after France first ordered a close examination of *her* mineral resources and the compilation of geological maps.

A few years ago it was said that about 47 percent of our country, exclusive of outlying possessions, had been mapped topographically, but at the same time one authority stated that of this 47 or 48 percent of the country "only about one half is mapped adequately according to modern needs and standards." As of today, the authorities are even less optimistic. The pressure is on again, the old urgency. The political pressure from the outside, the need for almost daily reappraisal of our natural resources, the frantic search for new deposits of rare metals, all these and other factors have once more set us far behind in our mapping. The adequate surveys of 20 years ago are no longer adequate, and our maps will never catch up with the progress of this fast-moving world without the help of an enlightened public willing to give their full support, both moral and financial, to a national mapping plan.

"WE'VE GOT A MAP"

The greatest enemy of progress is ignorance, and I think I am safe in calling maps the most used and least understood documents of modern civilization. The tendency of the uninformed to believe everything they see in print extends to maps and charts. These people have not been trained to examine printed matter with a critical eye, and they are therefore prone to accept without question the facts set forth, either in a book or on a map, as gospel. They have little, if any, conception of the virtues and limitations of maps or how to use them. It is no wonder, therefore, that the attitude of many of our people is, "why should we have any more maps—we've got a map." This sentiment is all too common, and is certainly not original with the United States Congressman who is supposed to have said it.

One of the obvious ways to overcome the apathy of the public toward maps is to let them in on some of the secrets of how maps are made—and how they have been made in the past—to show them that, contrary to public opinion, the Geological Survey, the Army Map Service, and such private firms as Rand McNally and Hammond do not get their geographical information by divine revelation. It would also help to demonstrate by means of cold, historical facts, that maps are the result of sweat and toil, the end-product of many hands and many pairs of eyes working under trying conditions; that they are not isolated documents capable of standing on their own merits, but compilations, representing an accretion of knowledge acquired the hard way and, therefore, subject to human error. The story of how this country has been mapped over a period of 300 years would most certainly breed a new respect and sympathy for the people who have tried, and are trying, to do it. It would also do a lot to develop in the layman a more critical and discerning eye towards one of the most useful mediums of world progress.

A HISTORICAL APPROACH TO CARTOGRAPHY

Working and living as we are in a hurry-up world, "under the pressure of stern necessity," it may seem a little ridiculous to suggest that a historical approach to cartography might have a salutary effect on the

people who are engaged in making maps and charts, as well as on the public at large. Yet I submit that history is the past telling the present about the future. Johann Georg Kohl, a great geographer who flourished about a hundred years ago, stated the case far more effectively, in 1856, when he was stumping for a separate Map Division for the Library of Congress. He said "If geography itself was neglected until our days, *the history of geography* must, of course, have been utterly unknown. Geography has too often been treated as if it were a science . . . which had no past. For this, geographers themselves are to blame; for they, in describing the actual state of countries, have just as seldom entered into their *history* as historians have entered into their *geography*."

"Yet no one can justly appreciate the value of existing information who does not know by what exertions it has been acquired. No man can rightly estimate any truth who is not aware of the previous errors through which the way to it led. A geographer ignorant of the history of his science is like the traveler of an Oriental tale, who finds himself transferred by enchantment into the heart of a strange country without knowing by what means he arrived there."

Now I grant you that, in this enlightened, technological age, the historian, vulgarly referred to as an "antiquarian" or worse—"a humanist"—is not in the highest repute. In fact, today he ranks as a kind of intellectual leper who is out of place in a world that is moving too fast for all of us. In such an age we may feel that we cannot afford to pause long enough for a look at the past, even though we might like to. Yet you men and women who are concerned with the mapping of the world or even a tiny part of it must now and forevermore depend on the history of your discipline, and a better knowledge of everything that has gone before will explain away many of the vexing problems which confront you daily. Moreover, your example and influence will inevitably result in an informed public whose understanding and support you must have in order to do the jobs that remain to be done.

Your inheritance for the job, your stock in trade, is a vast accumulation of incomplete records poorly preserved, quantities of maps that were hurriedly drafted, and boundary descriptions such as the Vermont surveyor uncovered a few years ago which defy the imagination and technical skill of the cartographer. This particular description of a piece of land, filed with the deed to the property, reads as follows: "Bounded on the North by Brother Jim, on the west by Brother Bill, on the South by Sister Sal, and on the East by Mother."

❦ ❦ ❦

Photogrammetry Laboratory Kit

John O. Eichler, Associate Professor of Civil Engineering, and Harry Tubis, Instructor in Photogrammetry, The Cooper Union, School of Engineering, New York, N. Y., have published a kit for use in teaching the fundamentals of photogrammetry.

The kit consists of a sturdy folder containing text, formulae, sample problems, six aerial photographs in two short strips of three exposures each, a photo index map, and two transparent overlays carrying control positions and designations applicable to problems in photo-interpretation.

The text consists of four chapters: Planning and Executing the Photographic Flight, Basic Photo-Interpretation, Selected Problems in Photogrammetry, and Radial Line and Mosaic Exercises.

Designed to provide a unique source of materials for basic courses in photography, the kit is recommended for educational institutions now offering courses in photogrammetry as well as those planning to do so, and for individual home study.

The kit may be obtained for the purchase price of $5.25 from Prof. John O. Eichler, 47 Clinton St., Newark 2, N. J. Teachers of surveying and photogrammetry may obtain the kit on 15-day trial.

The Surveyor in Court

By WILLIAM C. WATTLES

LAND SURVEYOR AND CIVIL ENGINEER, GLENDALE, CALIF.

Foreword

This article is the first of a number that are to be published in SURVEYING AND MAPPING as chapters or parts of chapters of a proposed Handbook on Property Surveying.

The Property Surveys Division has fostered the idea of a Handbook on Property Surveying for the practicing surveyor. Following three years of study, committees are now at work on the actual writing of specific articles and chapters to be included in the Handbook. These articles, when completed, will each be given a trial run in the Journal, in order to determine their suitability and acceptibility.

It is proposed that all such articles will be clearly labeled as proposed Handbook material. Members and readers are requested and urged to comment and offer suggestions on the material. All members are further urged to offer their help, and to contribute as much as they can to aid in the work of the various committees.

The Handbook Committee plans to study all articles to be published, as well as those that have been published in the Journal, as possible material for the ultimate Handbook.

It is the ambition of the Handbook Committee to develop, as soon as possible, a Handbook that will represent property survey practice of a professional level compatible with the standards and criteria already established by the Congress.

S. A. BAUER
Chairman, Handbook Committee

THE LAND SURVEYOR is often brought into court as a material or expert witness. He frequently provides the weight of evidence which determines the court's decision. The manner of presentation of the testimony as well as the content is important in its influence.

The surveyor and the attorney calling him as a witness should have a mutual understanding and accord as to the nature of the items at issue, the analysis of the problems, the applicable law, and the resultant opinions to be expressed in the testimony. The attorney will be able to examine the witness satisfactorily only if he is familiar with the basic principles and analyses used by the surveyor in the matter at hand; having such information, he can apply his legal knowledge and corroborative citations to best advantage. Knowledge as to the salient facts of the case, together with exchange of data on survey procedures and practices, with the attorney considering the legal aspects, will benefit both, resulting in a consistent and logical presentation of testimony by the surveyor in response to pertinent questioning by the attorney. Argument and discussion are valuable and necessary between attorney and surveyor in conference, but the expert witness does not indulge in argument, as such, on the stand; he sticks to direct answers to questions, letting the succession of questions provide the basis of counsel's argument before the court.

As a material witness, the surveyor is in the same category as any other person, answering the questions as briefly and directly as possible, covering factual matter only, as information personally acquired, and offering no explanations unless asked. Any testimony beyond these limits is subject to objection as hearsay, conclusion, irrelevance, or other technicality.

If called as an expert witness, the surveyor on the stand, under proper question-

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ing by his counsel, first recites his qualifications of training, education, background, authority (registered, licensed, employment position), specialization in matters pertinent to the case at hand; second, states the nature of his familiarity with the exhibits, documents, maps, and evidence presented to the court; third, when asked by counsel whether he has formed an opinion relative to the matter before the court, says that he has; fourth, when asked to express that opinion, gives briefly and specifically his "opinion" that the location or position of such and such lines or monuments in controversy in the case is so and so, without elaboration as to reasons or analysis; fifth, if asked to explain or set forth the reason for his opinion, he may develop his analysis, stating his procedure, examination of documents, application of theory, correlation of facts, and so on.

In direct examination, counsel will attempt to elicit answers from the expert witness that will give the court a clear picture of the facts and conditions of the case which counsel desires to present from his point of view. It is evident that the preliminary consultation between attorney and surveyor is a necessity. The surveyor does not practice law, but he can and should furnish information as a factfinder to his attorney, who will use the data legally in the court action. The expert witness, as well as any other, is under oath in his testimony, and must answer questions truly and to the best of his knowledge; but as an expert, he should confine himself closely to the interrogation of his counsel, limiting his answers to the statement of fact or analysis immediately applicable to the question, omitting extension or surplusage; counsel will extend the range of the testimony by his questions at his own pleasure and in his own manner.

Cross-examination by opposing counsel is the difficult phase of the expert's presentation of testimony. Effort may be made to confuse, discredit, or convert the testimony to the interpretation best suited to the opponent's view of the case. To this end, the same question may be repeated several times, rephrased in form, hoping to develop a construable variation in meaning from the various answers; the witness should be alert to this situation and return the same answer to each of the varied forms of the same question. If an answer is long and involved and in the rephrasing to subsequent questioning there arises the possibility of misconstruction of intendedly synonymous terms, it would be better if reference could be made to the answer previously given as disclosed by the court reporter's notes; in this way the line is clear and there is no confusion.

Although expert opinion or analysis may be rated hearsay or conclusions of witness in a technical sense, it can be presented as expert testimony without too much danger of objection; but the witness should stay clear of expressions as "I think," "I believe," "it seems to me," and similar ones, for these will most likely bring a sharp "I object," or "move to strike," as hearsay or conclusion of witness, or no foundation laid, and so on. The expert should answer questions by statements which bear the imprint of fact, not conclusion, or by prefacing the answer with "in my opinion." If a question implying a direct "yes" or "no" answer is not so answerable without qualification, the witness should so state and wait for the next question to be more specific.

If the witness is licensed in a state which authorizes him, under his license, to take oaths from persons interested in or having information about a boundary survey or matters pertaining thereto, he may present his written evidence of such oaths as support for pertinent portions of his testimony with little chance of hearsay objection. However, if testimony requires reference to conversation with a person not deceased, not in court, or whose deposition has not been presented to the court, then the statement of such conversation in factual form, "John Doe reported" or "he stated," rather than the weaker "he told me" or "he said" style, is less liable to attack as hearsay; or the form, "my analysis and information are corroborated by the statements made to me by John Doe," may provide opportunity for

further questioning as to the reason and necessity for such transmitted information.

Should the witness be asked "to tell in your own words," or some such informal phrase, the reply may be given with somewhat less rigidity of statement. Although any testimony in any form may be subject to objection, the effort of witness at all times should be to present his testimony truthfully, accurately, succinctly, and in such a manner that there will be a minimum of those objections based on such standard expressions as "irrelevant," "immaterial," "no foundation laid," "hearsay," "conclusion of witness," and so on.

It is to be remembered that the expert witness has the right to express his opinion, to state that the same is based on the facts he submits combined with an analysis of the various factors he has investigated, which "in his opinion" bear on the case, and which he presents as an explanation of the matters involved in order that the court may draw a conclusion. The surveyor is a factfinder and analyst who presents facts, applicable theories and rules, and his opinion of the relation between them; he may not legally draw a conclusion since he has no judicial authority. Only the court holds the prerogative of making the decision.

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Use of Surveying Methods and New Instruments for Industrial Application

(*A Panel Discussion*)

This panel, one of the highlights of the Thirteenth Annual Meeting of ACSM, convened on March 24, 1953, in the East Room of the Shoreham Hotel, Washington, D. C., Carl W. Keuffel, Instruments Division Chairman, presiding. Members of the panel were: Prof. Philip Kissam, Princeton University, Moderator; Capt. O. S. Reading, U. S. Coast and Geodetic Survey; and Jack Steele, Farrand Optical Company. There were no prepared papers and the entire discussion was on an informal basis.

—EDITOR

THE PANEL

Left to right: Prof. Philip Kissam, Moderator; Carl W. Keuffel, Instruments Division Chairman; Capt. O. S. Reading; Jack Steele. The device on the table is a jig alignment telescope with ball for mounting on aircraft jig

PROFESSOR KISSAM: It is a fact that as long as we are having a rise in the cost of human activities or, more particularly, a rise in wages, a man's time becomes more and more valuable. This means, certainly, that we have got to go more and more into mass production of larger and larger products. The aircraft industry has felt this very strongly during and since World War II. Mass production means better measurement. Larger products mean extremely high-grade measurement. And so the methods that have been used in the past by the toolmaker no longer are accurate enough. Obviously, then, with larger products, we must adopt surveying techniques, surveying methods, and surveying instrumentation. We can foresee this change going through all industry and moving slowly up into the larger products. I don't believe that this is a "flash in the pan." It is something of great importance and great interest.

It is true that the only people who know about the principles of surveying are the surveyors. The men in the shop are toolmakers or they are mechanical engineers. They have little to do with surveying. On the other hand, surveyors have been brought up with the ideas of accuracy, of the basic surveying principles, the principles of the use of gravity and of the optical line of sight, the principle that the observer must control, and the principle of reversal for the elimination of systematic errors. All those things come into this picture. It seems to me that there is going to be a great need for those men who are engaged in sur-

veying to go into plants and to demonstrate how to use equipment and how to apply new methods, and actually to set up and utilize the surveying equipment that must be devised in the course of this development. I have heard it said that a young man out of college who knows his surveying could be placed at a very high salary in almost any one of the plants that are trying to utilize this new development. It seems to me that practicing engineers have a chance here that is very important to them and certainly one which should be looked into.

I would like to mention briefly the subject of optical tooling because it is so new that many people may be unfamiliar with it. The toolmaker uses a taut wire and hanging plumb bobs. The aircraft industry is required to build airplanes with virtually perfect air foils today. Those air foils are designed for very high velocities. They have to be almost perfect. The aircraft industry also has to make airplanes such that a part of one will fit the corresponding part of any other ship of the same model. The aircraft industry has to manufacture airplanes of the same type in different localities so that one bomb won't eliminate the entire manufacture of a particular type. To handle this requirement, it was necessary at the beginning of World War II to ship the mock-up shapes from one place to the other by freight because dimensions would not carry values of sufficient precision. That was a tremendous job and practically an impossible one. With optical tooling there seems to be an opportunity to do this work by dimensions alone.

This development is very new. We are experiencing a sudden upsurge in the realization of the importance of optical tooling to the aircraft industry. I am sure that broad opportunities for optical tooling are present in every type of large-scale industry. And for that reason, this is, to me, one of the most thrilling examples of new progress that we have in surveying today. There are a great many questions that are bound to come up. For example, what part will civil engineers play in this program? So I think that the thing to do now is to try to get your opinions on what direction this development should follow.

I know that Captain Reading has some things to say and perhaps he would like to discuss what he thinks will be the developments of the future.

CAPTAIN READING: Back in 1946, a young Air Force captain came into our office and asked, "How accurately can you make optical measurements? We heard that the British are able to make Lancasters in Canada and ship them over to England and fit them exactly with parts made in England through optical measuring equipment. We wondered whether we could do it, because we realized that we were up against very high expense in shipping these big 'masters' from factory to factory. When we wanted to make Liberators in Detroit and have them fit others made in Fort Worth, we could not do this difficult trick. The manufacturers just weren't able to make parts in one factory according to drawings and ship them to another and have them fit similar parts." Well, we appreciated right away, in going out to see what he meant, that they were using the regular methods of the toolmaker. As Professor Kissam has said, they had been using taut wires and plumb bobs and they were scribing lines with trammels and steel scales on a bit of pressboard, laying out angles that were some 18 to 20 inches across that would be prolonged on a wing some 30 feet. They were doing this with little better than drafting equipment and apparently were lacking in the fundamentals that surveyors learn when they start to use instruments. They were using some stripped-down transits without circles that had largely replaced the taut wires for laying out lines, and they had adapted a special traversing device, like a machine screw feed, for moving the transit sidewise and wobbling in on line. They had hydraulic elevators to get the tripod at the right height or the standard at the right height when they wanted to do some leveling, but they were using the ordinary surveyor's transit with a magnification of around 15 or 20 and trying to read

hundredths of an inch on a steel scale at distances up to 30 or 40 feet. Well, the crosswire would cover a couple of hundredths, but the men who were toolmakers were accustomed to doing work to a matter of thousandths. Thus, they would claim to be working to 10 thousandths, when they were looking at a scale that they couldn't read closer than to about 20 thousandths. They would then spend much time in arguing who is right, the fellow who built the part or the inspector who checked it. Incidentally, all aircraft parts have to be carefully checked and approved before they are accepted.

We appreciated that the British instruments that were available were something a little different than the instruments on the shelves of the manufacturers of surveying instruments. The British had a telescope, for example, that would focus down to 2 feet and prolong a line that was correct within 1 or 2 thousandths up to as far as it could be read. The development of a focusing slide of that accuracy and the optics in connection with it involves a special technique. They had developed the use of a reticle at infinity focus to give a collimated line, that is, a sight on a line for tilt; and they also placed another reticle in front of the telescope so that they could determine the displacement of the collimator from the line of sight. They also developed very carefully scraped and fitted brackets to attach to the parts that they wanted to measure so that the telescope and collimator could be inserted on the bracket which in turn would determine whether the part to which it was attached was very accurately aligned, both in tilt of the surfaces and in the displacement. They had been able to build Lancasters in Canada and transport them to Europe from the drawings. Incidentally, they also used very carefully insulated micrometer rods for their measurements and as long as they did not measure over 20 feet or so, that was probably a very satisfactory method.

One or two American aircraft manufacturers got the idea that they ought to try the British equipment or the equivalent of it, but right away they found that their mechanics and their toolmakers had great difficulty in aligning these telescopes. The British had used a technique of fitting their very carefully hand-scraped brackets on these aircraft so that when they put the telescope and collimator in position they were almost aligned, and the slight adjustments necessary were not very difficult. But the Americans started to use six screws, of the push-pull type, to move these brackets; when they screwed in one, they upset the direction of the telescope and their men became so confused that they did not make much progress. Finding the difficulty was something like the argument between the use of a four-screw leveling instrument and a three-screw instrument. The men just did not know which screw to move to get the result they wanted. We suggested that they use a ball centered on the node of their objective, and then they could move the ball for displacement and tilt the telescope with a suitable bracket for line; that solved the problem. I see a telescope of this kind right here. Is this a K & E instrument?

MR. KEUFFEL: That happens to be.

CAPTAIN READING: This is the type of instrument they use. It has a magnification, I suppose, of around 25 or 30 times?

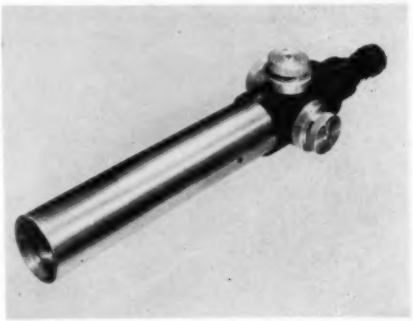

FIGURE 1.—K & E jig alignment telescope. This device is mounted in a ball and placed on the aircraft jig.

MR. KEUFFEL: No, more than that, 42 times.

CAPTAIN READING: 42—in other

words, it is a first-order telescope, and it has this ball which can be placed in a socket, in position on the jig they are trying to make. It also has here some micrometers so that after they get the line that they want with their collimator, they can measure the displacement of the target in thousandths, so that the toolmaker knows just how far he has to move the target to bring it right in. He can set tolerances on the scales so that, as he turns a micrometer knob this way and that way, if he is within the range, he knows that he is within his tolerance and that he does not need to position the target any more accurately. I am very happy indeed that the American instrumentmakers appreciate the needs of the industrial plants and that they are making the type of instruments that are required for working to thousandths at 20 or 30 feet or more. I heartily second what Professor Kissam has said. Most of these toolmakers are very adept at using gages. They know how to use dial gages and surface plates and Jo blocks and all the devices for high precision measurements—as long as they are working on a surface table. In some factories they even try to get 10 or 20 great heavy surface plates, that weigh about three-quarters of a ton each, all lined up to give them a plane so that they can use their accustomed methods. It wasn't long until the surveying firms taught them there was such a thing as a precise level with a tilting plane-parallel plate in front of it, moved by a micrometer dial, so they could read the height in thousandths as well as they could with their ordinary surface gages.

I can also heartily second what Professor Kissam said to the effect that if we have well-trained surveyors they can contribute a great deal to all these shops that are making parts or devices larger than about 5 or 6 feet in length. They need very high-grade instruments, and I am very glad that the American manufacturers are taking it up. They are very ingenious. There are several engineers, Mr. Mades of Boeing, for example, who wanted to swing a plane perpendicular to the line of sight as set up with these collimators and telescopes. He hit on the idea of putting a mirror on the horizontal axis of the telescope so that he could look along this line of sight and be sure that the telescope of the instrument would swing such a plane. We need not fear for their

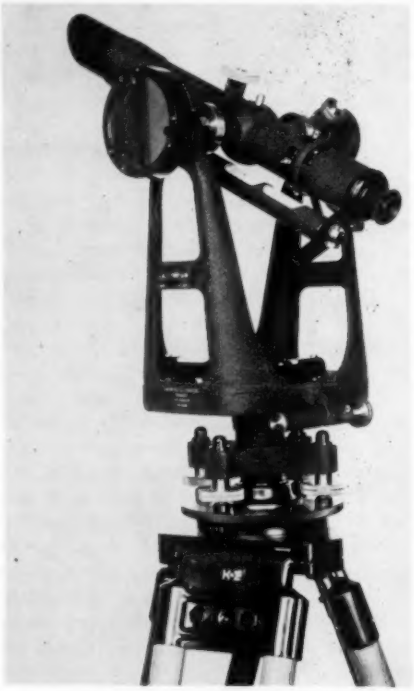

FIGURE 2.—A jig transit. It has no horizontal or vertical circles, only one motion, but the crosswise level is as sensitive as the telescope level. Note the axis mirror and the collars for a striding level.

ingenuity. Once they get the idea there is such a thing as surveying, they can depart from their surface plates and begin to do very accurate work.

We have also received excellent support from the manufacturers in another direction. They needed to make some long measurements, or at least thought they did. I understand that now the need is not quite so great, but we rather hesitated when they were stringing out micrometer rods 30 or

40 feet and putting them on a board to support them in a more or less straight line. Well, knowing that there is such a thing as friction and that reading an inside micrometer depends a little on the feel, we looked into the matter of furnishing accurate tapes and K & E was able to make a set of tapes that were 100 feet in length and were all within 6 thousandths of an inch of the standard value as calibrated by the Bureau of Standards. They had no error in excess of 2 thousandths of an inch in any 5-foot length. Those tapes were so good that they don't even apply corrections when they use them in the factories. That, I think, is a very great testimonial to the skill of the American instrumentmakers in meeting the needs once they get the demand.

PROFESSOR KISSAM: Thank you very much, Captain Reading. I think, before we go any further, I ought to try to picture what a jig looks like. I know that when I was first introduced to this subject I could not imagine what these people were talking about. Maybe I can give some picture of it. A jig is a large steel structure. It may be 60 feet long. It is made of large sections of tubular steel welded together. This structure usually rests on a concrete floor. Presumably it is in a room whose temperature is controlled by the air in the factory, an enormous place. To the jig are attached many small parts. These parts are made by the toolmaker, using ordinary toolmaking techniques. The problem is to put these parts in the right places. The basic principle usually is first to establish one line of sight, then to establish a distance, then to position each part with a locating device. This carries targets which must be located on the line at the right distance and then at the right tilt in both directions. That is the problem as far as the jig is concerned.

In addition to this, there are a thousand and one little surveying problems that come into the picture. For example, they have to make mock-ups. A mock-up is a shape made of steel templets and wire and, believe it or not, plaster of Paris, which forms the shape of one of the parts of the airplane. That mock-up is the basis of all other measurements. The gages are made to fit its surfaces. This means that it has to be made with tremendous accuracy. And I might point out that when Captain Reading says thousandths, he means thousandths of an inch, not thousandths of a foot. Thus, there is a necessity for ordinary surveying methods to control these mock-ups, but they must be executed with extreme precision.

In addition, there are very unusual surveying techniques that have been developed to control the position of various parts that make up the final jig on which the airplane is assembled. Sometimes two lines of sight are used. That takes one of the tilt problems out of placing a part. Then only one tilt remains.

CAPTAIN READING: It takes out the rotation.

PROFESSOR KISSAM: It takes out the rotation and leaves one more tilt. There is another technique which Captain Reading mentioned, the technique of right angle to a line in which a mirror is put on the horizontal axis of the telescope. Then, of

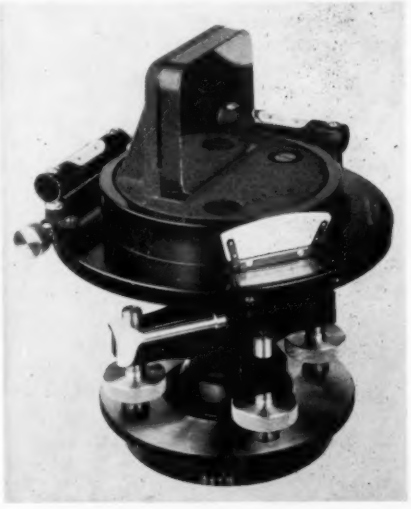

FIGURE 3.—An auto-reflection angle mirror. This device is used to establish horizontal angles measured from a line of sight.

FIGURE 4.—An optical micrometer. Placed on an instrument, it moves the line of sight laterally by an amount indicated on the dial.

course, that mirror can be adjusted so that it will be absolutely perpendicular to the axis of rotation. Such things are being developed every day.

One point should be made very clear to some of you who are not familiar with it. Consider a telescope like a transit telescope being used to produce a line of sight. If, in front of it is placed a piece of glass which has two plane surfaces that are parallel, and then that glass is tilted, the whole line of sight is moved parallel to itself. So that once a line of sight is established by pointing the instrument at a target, then, by tilting this piece of glass, the line of sight is moved parallel to itself by a very small amount. In moving it parallel to

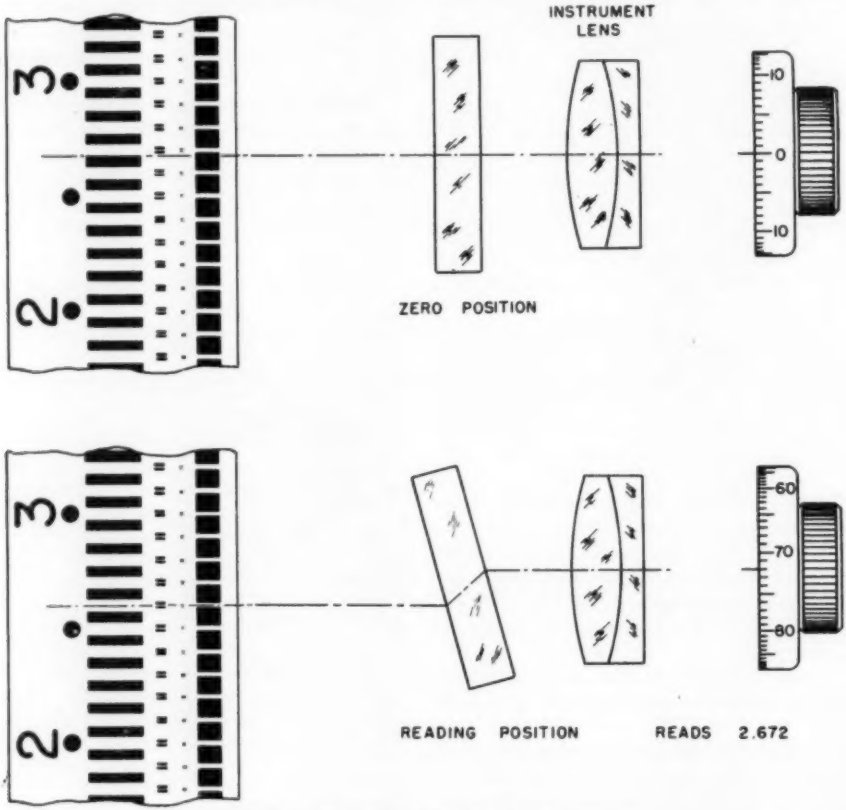

FIGURE 5.—Principle of the optical micrometer.

itself, a dial is rotated and on that dial is marked the thousandths of an inch by which that line of sight is moved from its original position. You will see on that telescope on the table a good illustration of a dial that moves the line of sight up and down and another one that moves the line of sight left and right. Now, Mr. Keuffel said he wanted to say something and we will ask him to do so at this time.

MR. KEUFFEL: Well, you said about what I wanted to say, but I think I can add to it. I heard about all these measurements they are making and the wonderful accuracy that was claimed and I must say I was very skeptical. A couple of weeks ago, however, I visited a Boeing plant at Wichita where B-47's are being made. I also went to Kansas City where the wings are made in a big Ford plant and then shipped on two flat cars hitched together to Wichita where they are attached to the B-47 bombers. What I saw at Ford was several of these tremendous jigs, longer than this room, higher than this room, and half the width of this room. The right wing was being assembled on one side, the left wing on the other side. These big, long jigs were made the way Professor Kissam said. They were tremendous steel structures. The alignment of the jigs themselves was being controlled by means of alignment telescopes, as these devices are called. An alignment telescope was placed at one end of the jig and a target at the other end. The target is fixed, and the device that holds the sphere (the socket, one might say, for the sphere) is fixed—it is part of the jig. They can take the alignment telescope out and put it back again and sight it at the target any time they please. Then, using these lines of sight (sometimes they have three of them) they place gages at distances along the whole length where this big wing is to be assembled. What they measured with these optical means was the jig or the gage. They did not measure the wings. They then made the wings to fit these gages, and the accuracy that they actually got was remarkable to me. I did not think they could do it, but they are doing it. They are working with very, very close tolerances.

I feel that these companies do not use the services of surveyors, people who really know something about measurement as applied to large structures; and that is why I thought that a meeting such as this would get the surveyors themselves interested and perhaps we could improve the whole system of measurements, not only in airplane factories but for many other applications. Are you going to bring some other applications in, Mr. Steele?

MR. STEELE: I will touch upon them briefly. To begin with, I represent Farrand Optical Company in New York. We have gotten into optical tooling in the last three or four years. There is a big demand for it, and we saw a chance to make a dollar. I don't know whether we will ever do so. Ralph Hamilton has recently come with our firm. Now, Hamilton was with Lockheed and other aircraft companies in California for a great many years, and I think there are very few people in the country who know more about optical tooling as applied to aircraft construction than Ralph Hamilton does. We are happy to have him with us. He is now in a position to call on the industry and spread his knowledge around where it can do the most good. He certainly could give us a great many more precise applications of this problem than I can. I am a nuts and bolts man. I did much of the optical design on our optical tooling.

To start off, I would like to get a little idea of how we are represented here. Do we have very many in our group who have had experience in optical tooling, other than surveying? May I have a show of hands. I see no one put his hand up. So I guess I can speak freely (laughter). I went to Rensselaer Polytech. I know that in the Spring of my freshman year I had a surveying course, and we had to trot our lines around the campus and end up where we started from, as close as we thought we could get away with it by fixing up the notes. And if we were, as I recall, tenths of a foot and hundredths of a foot out, we

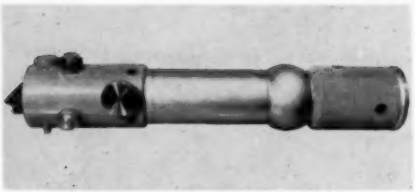

FIGURE 6.—Farrand alignment telescope.

were considered pretty close. If you put down thousandths of a foot, you were looked at over the top of the spectacles. In aircraft tooling, thousands of an inch is exactly what they go by. And in some of the high-speed jet aircraft, the designers (the ivory-tower boys) claim that the tip of the wing should be within 1 thousandth of an inch from its nominal position. Well, the fellows who are building the ship try it. They hope they can get within 5 thousandths, and they usually are satisfied with a little bit more than that. Inspection tries to keep them down to 5 thousandths of an inch in many of the locations: trim tracks, ailerons, and hinge points.

Now, to place a position 120 feet away within 5 thousandths of an inch is quite a trick. It calls for precise optical tools. Instruments are being built today which can do that, and there are a great many men in the aircraft industry who have learned to use these instruments. That is where the great wealth of our ideas come from, from the men who are using these instruments in the field. The manufacturer may design an alignment telescope and say it is to be used for this, that, or the other purpose, and it will serve that purpose. The first thing you know, you go out to see these fellows and they say, "Joe, I can get your telescope to do this, that, and so on and so forth." It has become our problem, in manufacturing these instruments, to make the tools that are needed in optical tooling, and to work with the men who are using them in devising new tools which will give us greater precision and greater accuracy, and to spread the use of optics further and further in industry.

I am particularly familiar with aircraft optical tooling. But these very same optical tools have been used in the past for the construction of large machinery, for laying out and setting up the machines, and for aligning journals in large generators and turbines. Optical tooling is not new, but its application is always new. Every day we have new applications for optical tooling, and these are the points that we are trying to work out now. The field has just been scratched.

The old masters which they used in building airplanes for interchangeability of the parts were, as Professor Kissam pointed out, extremely cumbersome. I was at Boe-

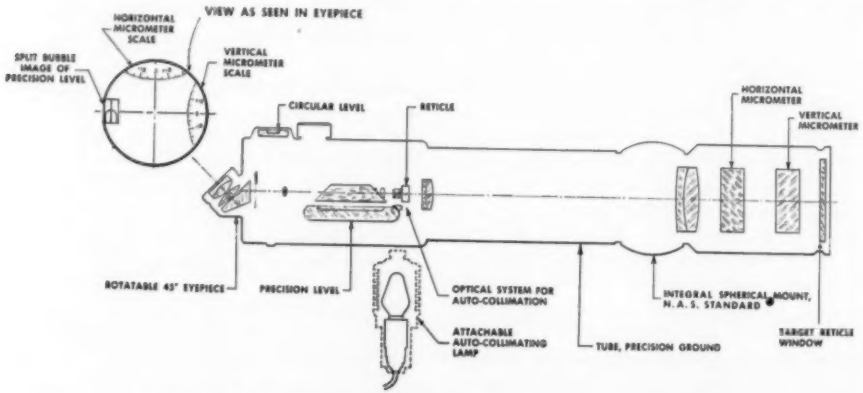

FIGURE 7.—Schematic representation of Farrand alignment telescope.

ing a year ago in June when they started on one of the new programs. They had a jig master, which was just a pattern made up of heavy welded-steel sections to master the jig structure where the root section of the wing joined into the fuselage. That master weighed over 9 tons. Every so often the jig which is producing aircraft parts has to be inspected by the Air Force inspectors, and usually, in times past, they were satisfied only when the master which bore their seal and their inspection approval was put into the jig and the jig checked out against the master. On some of these large masters, this meant that the jig had to be taken out of production for as much as ten, twelve, or fourteen days, just to get this big bulky object from tool storage out on the floor and into the jig, checked, and back again. Now, with optics, the heaviest thing you have to carry around is an alignment telescope. But, optics will not completely replace masters. With many small mastering applications, it is simpler to build a master tool than to go to optics, but there are even some who believe they can do away with masters entirely by using optics set up in some such way that they can check off a lot of small jig assemblies.

Our typical jig structure, as the Professor pointed out, has been made of large welded-steel pipe. Some of the larger ones that we have seen at Boeing were made of struc-

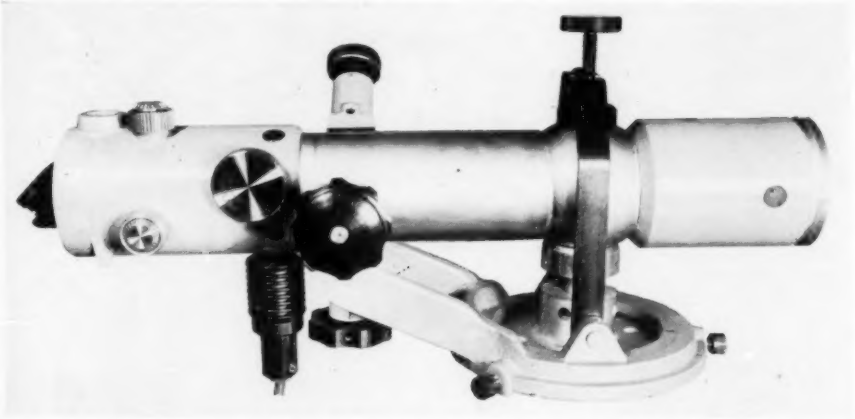

FIGURE 8.—Farrand alignment telescope shown with auto-collimating lamp chamber attached and mounted in adjustable telescope bracket, adjustable cup mount, and cup mount clamp.

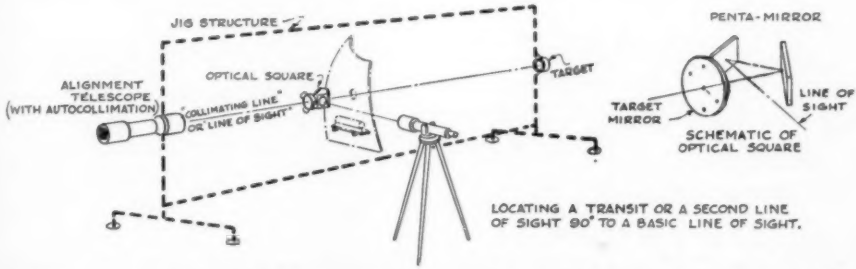
JIG STRUCTURE
OPTICAL SQUARE
TARGET
ALIGNMENT TELESCOPE (WITH AUTOCOLLIMATION)
COLLIMATING LINE OR LINE OF SIGHT
PENTA-MIRROR
TARGET MIRROR
LINE OF SIGHT
SCHEMATIC OF OPTICAL SQUARE
LOCATING A TRANSIT OR A SECOND LINE OF SIGHT 90° TO A BASIC LINE OF SIGHT.

FIGURE 9.—A typical optical tooling problem: locating a transit or a second line of sight at right angles to a basic line of sight.

FIGURE 10.—Farrand optical square.

tural steel, and the two sections for right and left sections of the wire were 160 feet long; they were a good four stories high; they had second and third mezzanines on them and optical sighting points all over them. One basic optical reference line was established and then others in relation to it. All these facility gages (that is a common expression that they use) and check points are established on this structure so that when they start to build a section of the ship in that jig, they can pick up a rib and bring it up to the jig and it will be positioned by the facility gages on the jig and clamped there. Then the next member is brought up and set on its facility gages and clamped there. As to the position of these clamping members, these facility gages—that is where the optical tooling comes into its strong point. They are positioned by optical tooling and the parts brought in and assembled and then welded and riveted with the correctly located facility gages to hold them true.

PROFESSOR KISSAM: Gentlemen, I want to say a word or two about the history of this development. When it was first realized that surveying methods had to be used in the aircraft industry, ordinary surveying instruments were, of course, applied. The first indication in this country of this development was, I believe, at the Douglas plant where they adopted an instrument designed by Mr. Berger called the jig collimator. That was a special transit designed for optical tooling. I hope I am right, Mr. Berger.

MR. BERGER: That is correct, Professor.

PROFESSOR KISSAM: Then, shortly after that, Mr. Caesar got the Wild Company to change the size of their plane parallel so that instead of reading in millimeters it read in inches. That was a great step forward. And then came the interesting English development that Captain Reading has described. I want to point out that Captain Reading has gone way beyond this. He has a machine which places these parts according to actual readings. So I think that carries history a little further.

Now, I think from the description that was given by Mr. Steele, a much clearer

FIGURE 11.—Glass target shown assembled with spherical mount, adjustable cup mount, and cup mount clamp.

picture of optical tooling has emerged. It seems to me that now is the time for any of you who have a question to ask it. Does anybody want to ask anything about what was said, about what optical tooling really is? Has it been made clear?

MR. HIGBEE (W. & L. E. Gurley): Professor Kissam, there has been only one side of the picture presented here. I had hoped that you would have someone here who could perhaps talk on the other side of the picture, with regard to these fixed tooling frames which employ the type of telescope that we see on the table here. I think optical tooling goes further back, with all due respect to Mr. Berger and the special instrument which he constructed and which he called the jig collimator, because they used standard surveying transits for many years before that instrument was constructed. They are still using standard surveying instruments in these airplane plants. It goes back to the date when they were setting the scroll casings and things of that sort for the turbines that had to be very precisely set in power plants. You are talking about thousandths of an inch. We used thousandths of an inch in setting scroll casings some 40 years ago when I was in construction surveying. What we were trying to get was an optical line of sight in two directions. We used two instruments which we set up and leveled. We could then plunge them and get planes which were perpendicular and get planes which were parallel. That same thing was carried into the optical industry, in locating the points in space. I made a survey of the airplane plants two years ago, and last summer I visited the plants on Long Island and the plants on the Pacific Coast. I did not stop in Wichita because I saw the Boeing plant in Seattle, and they told me they were doing the same thing at Wichita. There is a great difference of opinion in the industry as to whether they should adopt this fixed framework, which employs these optical telescopes such as we see here, or the use of ordinary surveying instruments or stripped-down instruments, as they don't need to read horizontal or vertical angles. They are just trying to get two planes in space, one a level plane and one a perpendicular plane from which they can measure and locate the assembly of these small jig fixtures. I am not competent to talk on the details of it and how they are employed. We put a man in the Grumman plant on Long Island for a while, working with them to study their procedures. Grumman is one of the plants that is still using surveying instruments, and they do it for this reason. It is costly to build the jigs to take these special telescopes which, I think, in the industry are known as the Taylor-Hanson telescopes. Am I right?

MR. STEELE: No. They are known as the Farrand and Keuffel and Esser.

MR. HIGBEE: It is costly to provide the locating holes for the use of these telescopes. The use of a standard surveying instrument or, let us say, a stripped-down surveying instrument is much more flexible. It can be moved around, and, I think, within the tolerances of 5 thousandths of an inch, they are working and working very well. That was my observation and what I got out of the plants that I visited. It has been a tooling procedure. However, the whole thing has been developed by toolmakers and not by surveyors. I visited one plant which had employed a surveyor, and he was trying to introduce surveying methods, but the toolmakers so overpowered him that they would not listen to him. This is more of a toolmaking procedure than it is a surveying procedure. I am convinced of this. We were going to proceed along this line, as I say, and I put a project engineer on the job to follow it up, but we got so involved in making the circles and reading systems for Mr. Reading's coordinator that we had to pull him off the job to finish that up on time. And he never got back on it. I do think that these Lancasters which were sent over to England in the early days were made with standard Gurley instruments, for the most part.

MR. KEUFFEL: Mr. Higbee, this type of instrument is called a jig alignment telescope.

MR. EGY: (Brunson Instrument Com-

pany): We have been very fortunate in being close to the Wichita plant of the Boeing Company, and we have been back and forth with each other a good many times in the last several years. There is another phase of this which I think might be of interest. The surveyor has recognized that his instrument is not always in perfect condition, and not so many years back it was customary for a good levelman on the wye-level to check his adjustments the first thing in the morning, when he finished the morning's work, when he started the afternoon's work, and when he finished the afternoon's work, recognizing that there are little shifts in adjustment. Now, the accuracy that Captain Reading has mentioned, and which is asked for, and which is important to the airplane people, is just a little bit beyond the ordinary use of surveying instruments. As Captain Reading indicated, we have to have very careful attention paid to the making of these instruments. There is still the possibility and the probability that an instrument does not hold perfect adjustment to this degree of accuracy. We have the problem, then, of checking our instruments just as the surveyor has always done in his work. This is difficult to teach a toolmaker. A toolmaker must have a micrometer which reads right, in his opinion, and he takes a reading, and that is it. He is not familiar with the idea of checking up the optical line of sight because it is very sensitive to temperature changes. For instance, I could put my hand on the top of this telescope, and it would be a little bit out of line for a few minutes until the heat from my hand had been dissipated and the instrument obtained a uniform temperature.

We have been very fortunate, in working with the Boeing Company in Wichita, in having some men there who were alert and willing to accept ideas and suggestions and to study their problems. I feel that it is very important in all these airplane plants —and I have been in, I think, practically all of them in the United States a number of times—that they have what we call a three-point program. In the first place, they must get a good instrument accurately made. They must have a system of checking that instrument regularly and knowing that it stays in alignment. The particular Ford plant that Mr. Keuffel mentioned has found that a number of its instruments, in the course of one day, will get a little out of alignment and should be rechecked. And the third point of the program is that the men must be trained in using optical instruments. As Professor Kissam has indicated, the toolmaker is not an optical man, or has not been up to now; he will have to learn that he must use these instruments properly because of distortion from the heat of the hands or blowing his breath on a bubble or something of that sort, which is well known to the civil engineer. So we have been preaching this three-point program around the shops: get accurate instruments well made; have the means of checking them regularly and often; and train the workmen regularly. Boeing in Wichita has set up a regular school now for all men who are to use optical instruments. To illustrate this, I was in the Wichita plant one day when an inspector came around and Boeing was ready to sell the inspector this particular assembly. That is the way they speak of it in the shop, "We have to sell the inspector the goods." They brought in a level and set it up. The inspector took a shot and he did not get the right answer. So he took out his little notebook and wrote down the serial number of that instrument. They said, "Maybe the instrument needs adjustment." He replied, "Take that one away and don't ever bring it to me again. I won't use it. Bring another instrument." That is why we must have schooling in the toolmaking class for optical instruments.

PROFESSOR KISSAM: Thank you very much, Mr. Egy. That story of yours brings to mind another one which indicates how a surveyor could help out in these plants. I was down at the Lockheed plant at Marietta. The first step in making a mock-up is to establish a surface plate, which is something like 20 feet square, so that it is level. They told me they were

having a great deal of trouble with these plates, particularly with inspectors like the one just mentioned by Mr. Egy. The plate would be set up and the inspector would check it and find it was wrong. I might say that underneath the plate are many jacks, so that you can jack it up almost anywhere you want it. Here was the process that was being used to level that plate. A transit was set up and leveled carefully with the telescope level. After that, the instrument was used without changing the position of the level of the telescope at all. It was aimed at the four corners of that large plate and rod shots taken with steel scales to those parts of the bench plate. With my own eyes, I saw that bubble at least two and one-half divisions out of position. When they were taking these shots, I said to the man who was using it, "Why don't you level the instrument?" He said, "I already have and I never touch it again." We all know that we have to balance backsights and foresights when working to thousandths of an inch, because no human being can adjust a telescope to the accuracy necessary to avoid such balancing. They stand off in one corner of the shop and shoot in the four corners of the plate all around the edge, from one position, so that every shot has a different length. Now, any surveyor, as I see it, knows that that procedure is wrong; and, needless to say, until that was changed, there could never be an agreement between the inspector who had his instrument set up in one place and the toolmaker who had his set up in another place.

I have got to go back a little further just to show where the surveyor comes in. I remember so well a beautiful Berger level, a great big one, being used to level a B-29 out at the Modification Center in Denver during the war. That beautiful instrument was brought out, and the first thing the toolmaker did was to level up in one direction, rotate 180 degrees and the bubble did not quite come to the center. So then he adjusted it so it did. "Never mind the line of the sight. Don't pay any attention to that. It has to stay level when it is turned around." And then he shot on that airplane by taking a little shot here about 15 feet long, another shot over there about 45 feet long, and then he said his airplane leveled. That is another case where the surveyor would know better.

As I pointed out, there is a tremendous field for ordinary surveying instruments in this game. The advantage, as I see it, of the alignment telescope is that it is set up, as it were, in and as part of the jig. Any instrument that can be taken out of the jig, used somewhere else, and put back in the jig in exactly the same place, serves the purpose of the alignment telescope. That is the key thing: the line of sight can be regained even though the instrument is moved. That to me is something different, but it does not mean that there are not a thousand and one uses for ordinary surveying instruments.

Gentlemen, I was thinking, when Mr. Steele was speaking about accuracy, that when you come down to it, the accuracy now demanded is one part in 200,000. When we compare that with first-order operation, which is supposed to be one part in 25,000 (although it gets up to way beyond that, that still is the theoretical value), we see that optical tooling demands extreme accuracy. There are things that you don't think about. For example, a transit has a line of sight. It has a vertical axis. The two must *coincide*. For this kind of work you can't have one offset from the other, because if you do make a direct shot and then a reverse shot, you have offset your line of sight perhaps 2 or 3 thousandths of an inch. They have to coincide. There are lots of things different about optical tooling. You can't ever use a plumb bob because you must place your line of sight on line, not place the center of the transit on line. So you have to buck in, always. Every operation must be bucked in. You can't ever use the plate level. It is not accurate enough. Can you imagine the job of bucking in? Every time you move the instrument, you have to relevel it by means of the telescope level. That is something to think about. It takes quite a

while. You have to try the sight, move the instrument, relevel with the telescope level, try it, think how far you are going to go, move the instrument, relevel the telescope level, and so on. It is pretty tough. Of course, the aircraft industry has developed certain things, as Captain Reading said. Now they slide the transit back and forth on little ways like a lathe. This device is called a mechanical lateral adjustor. Mr. Berger manufactures them. But even with these, you have to level up again, because those ways can't be perfect and the least shift of the head of the instrument moves it way off line if it is not absolutely level. Instead of that, nowadays, you can move it on line by a piece of glass (a plane parallel). When you turn the glass to move the line of sight you can buck in quicker, because you don't disturb the leveling. These are the kinds of things surveyors must think about. One second or one part in 200,000 is a tremendously rigid specification. I don't think that many of us ever survey to one second. It seems unbelievably small. It is something way out of this world, as far as the surveyor usually goes, in accuracy, and it has the disadvantage of having to be done within a small area. So we have to apply every bit of surveying knowledge that we have to this application, the greatest care, and, I think, the most careful form of instrumentation.

PROFESSOR McFARLAN (University of Michigan): Was this work all done under temperature control or in air-conditioned rooms?

PROFESSOR KISSAM: Theoretically, measurements to an accuracy of one second are the province of the Bureau of Standards. That is the kind of measuring you do down deep, where the floor is good and solid. Unfortunately, aircraft plants are not so located. They are on the plains of Kansas. They are on the shore at Seattle where the buildings rise and fall with the tide and are subject to all sorts of variation of temperature. In some of these large buildings, the temperature in the fall may be down around 45 or 50 degrees in early morning and by noontime up to 85 or 90 degrees. These are conditions that the toolmen know exist. They are known problems, and they have to apply means to correct them. And they have attempted to do that. In the large steel jig structures that we speak of, there is now an attempt to make the main longitudinal member of aluminum. That member floats free, and all precise measurements are taken from it.

CAPTAIN READING: I think we might just say that some of these tolerances that Professor Kissam is speaking of are target tolerances and not achieved in practice. They do, however, measure their steel jigs with steel gages and with steel tapes, and they put aluminum parts in them. I think for a change of one degree Fahrenheit there is about one thousandths of an inch difference in about 12 feet between steel and aluminum. If a hangar door is open when a factory truck comes in, the temperature jumps 5 degrees for a while. Checking is done to tolerances which can be met and which are necessary for the parts to work the way they should. In many cases they are working to 10 or 20 or 30 thousandths, while in some of the longer parts they don't care if it is a quarter of an inch longer than 100 feet and they don't worry about it. The parts they do have to measure accurately are those that fit another major piece at the junction plate. It is possible by measurements to do away with a large number of the very heavy masters of 9 tons or so that we are speaking of and get down to just the actual hole checks or gages. But they always come back to the fact that they dislike to apply corrections, if there is any way around it. The toolmakers are not educated to apply corrections or compute corrections. For example, I think we had a tolerance of 2 seconds which was met in repeated tests in the telescope focusing slide for any length of line. We had special collimators put through the test and rotated so that we could say that they would not need to apply a correction to the line of sight as generated by that telescope when they set the targets.

Certainly an educated surveyor could help these people; and, I think, if any of

you have a chance, you could well look into the prospect of doing something to help the instrument manufacturers. If they will meet these tolerances, and I presume they are doing so from what I hear, they will save many man-hours of arguments between the inspectors and the toolmakers. As Mr. Higbee pointed out, they certainly need help.

PROFESSOR McNAIR (Cornell University): I would like to pose a problem. It seems to me that we are now reaping the benefits of the teaching that has been going on in universities for the last 15 or 20 years. Of course, I realize that we don't expect a toolmaker to be a surveyor or to have had training in engineering colleges. But it does seem to me that the mechanical engineers, the electrical engineers, and others should have had some training in surveying. As most of you know, the amount of surveying taught at engineering colleges has dropped, even for civil engineers, to a bare minimum, sufficient, let us say, for staking out a highway or for staking out a building. As far as mechanical engineers are concerned (and chemical and electrical and others), the students in a majority of the colleges receive no instruction in surveying. How can we then expect them to know anything about surveying instruments inside in a plant or outside on a survey job? We are reaping the reward of this, it seems to me.

It seems to me, also, since the civil engineers are all occupied, that there are plenty of jobs for them without going into the tool and die industry. We must do something to impress upon the colleges the importance of this work. We need to do something to bring to the attention of college administrations the job that can be done with the basic fundamentals that are taught in surveying, so that they can reinstate the courses in their curricula.

The problem I would like to pose to the Instruments Division is: How can we bring this to the attention of the educators so that they can know the importance of this basic job of teaching fundamental measurements?

MR. EGY: It might be interesting to know that the University of Kansas in Lawrence has already taken up this subject and has planned to have a week's clinic sometime this Spring on the relationship between surveyors and surveying instruments and toolmakers and their problems in the airplane plant, with the idea of starting a course in the school. How far that has gone, I don't know, because I have not been in touch with them for several weeks, but it was planned that they would invite people from all over the country, from the airplane industry and from the schools, to discuss exactly the problem which you have brought up and to try to introduce a course or courses in measurements as such.

PROFESSOR McFARLAN: I would like to say amen to what Professor McNair said; and, further than that, the situation is worse than he pictures it, I believe. I am quite sure that in many schools they are not teaching the principles that are involved in attaining accuracy. They are teaching the trick of running surveying instruments, and there is a vast difference.

And on the time element, we are confronted constantly, and I know other schools are, with the idea that any fellow who has not given thought to a subject for years, any Joe who has once had a course in surveying, can pick up and become a teacher in surveying. I maintain that, fundamentally, all modern scientific development is based upon the making of measurements. I won't qualify that a bit, and until we become intelligent enough to realize that it takes time to develop ideas, develop real meaningful concepts of precision, we are going to have trouble in our industrial life.

MR. DIETZGEN: I just wanted to say that we must be very careful, in talking about the educational problem, not to lose sight of the fact that optical tooling is a highly specialized field that really calls for the services of trained specialists. I don't think that we should for a minute show confusion and say that this field is not highly technical and highly specialized and that we should jump to a conclusion like that mentioned by the previous speakers. What I mean to say is that optical tooling

is not, in my opinion, a very broad field. We should restrict our discussion, I believe, to the specialty that we have attempted to discuss.

MR. MILLSTEIN (Michigan State): I think, going back to a previous statement, that crudeness yields argument and argument yields waste. I think that at the same time you are achieving this accuracy you must continually school yourself to the limitation that will result in a problem. For instance, we are very happy to reap the benefits of the optical applications, but we must face the fact that although we have built the jig, as soon as the part is released from the jig it will probably spring into a new shape so that it will be hard to get it back into the intended shape. Consequently, jigs will probably remain heavy. Also, we may find that we will have to build the jig a little bit deformed so that when the part is released from the jig it will spring into the shape we want. When you rivet a line of rivets and you start at the left end and go to the right, it will cause a certain deformation that the part did not have when it fit the jig in the first place. When you take it out, it is going to spring into something new. So I think the surveyors who tend to go into this kind of work need to have a philosophy to go along with that kind of work.

MR. BOLTER: Can this application of surveying methods to problems of positioning and alignment that we have been discussing here this morning, be utilized elsewhere? All our emphasis so far, or the major portion of our emphasis, has been on the aircraft industry. Can these methods be utilized outside of the aircraft industry to advantage?

MR. HICKS (Ann Arbor, Michigan): The Fisher Body Company uses these methods in establishing their lines and grades for the contours of their bodies, turret tops, and so forth and has been using them for years. They have used antiquated methods in doing so. They haven't had the new methods these instrument men are talking about, but they have had the tables, and I will say it goes into all industries of that type. I was employed during the war at Willow Run and all that has been said here today is true. When we first started that plant, we had to establish our lines and planes and so forth with transits and levels, and we did not have the modern equipment that you are speaking of today. That was during the first World War.

MR. LUNSFORD (Fort Belvoir Engineer School): The Army Engineering Development Center will be the testing laboratory in the United States for all jet-propelled motors. It will be to jet-propelled motors as Wright Field is now to regular type airplanes. We are being constantly asked about tolerances to thousandths of an inch, for establishing equipment at this plant.

I went down to the Norfolk Dam in northern Arkansas when the project was about a third finished and they were installing their first turbine and generator. They were trying to set the speed ring to a tolerance of a thousandth of an inch. Inasmuch as they did not have a level that would focus within 9 feet—the ring had about an 18-foot diameter and a 9-foot sight was necessary for setting up at the center—they used a Berger transit, as it focused in that range. Now, the accuracy to which the bubbles on a transit are normally ground does not even approach that type of accuracy. By using calipers, I showed them that the processer could be moved as much as 5 thousands of an inch without being observed on the bubble. We wound up on that particular job by using a small K & E level, and we obtained an extra gadget to go on the end to shorten the focus; and after considerable repetition, we were able to come into the tolerance asked for.

One of the difficulties that I found in using a normal surveying instrument for such tolerances was in obtaining a rod or some type of accurate measuring device which you might shoot on. Now K & E has a small 1-foot rule on exhibit at this meeting, graduated, I am told, to thousandths of an inch.

Now, gentlemen, referring to the aircraft

industry and making measurements from the tips of wings over to the planes, a distance of say 100-odd feet, when there is a little bit of temperature change you would get into the thousandths of a foot. So when you measure 100 feet, and talk about tolerance of thousandths of an inch—well—it just takes a little breath of air going by to change 100 feet by thousands of an inch.

MR. STEELE: One little point. When I spoke of thousandths of an inch at wing tip, I did not mean in length. I meant the elevation rather than the length. The length is relatively unimportant. I should have made myself more clear on that.

PROFESSOR KISSAM: Mr. Rappleye is in the room here. I was wondering whether he would like to say a word or two.

MR. RAPPLEYE: The application of precision surveys that I have been interested in of late might be considered in connection with the building industry. I was involved with the precision leveling necessary to control the underpinning of the White House when it was being rebuilt. The tolerance that we were held to at the beginning was 1 millimeter. Now, mind you, we were outdoors and we didn't have any constant temperature room and had the sun shining on us and the wind blowing on us and everything else. They set a tolerance of 1 millimeter. In other words, if that building settles 1 millimeter, we should be able to prove it. In order to do this, we had to hunt for tenths of even that. We used the Wild N-III instrument with the plane-parallel attachment; specially constructed bench marks, which were 11 feet above the ground; and our regular geodetic rods. Every single sight was made to hundredths of millimeters by estimation on the scale in the Wild instrument. Each pointing was the mean of three sets if the spread did not exceed one-tenth of a millimeter. If it did, we made two more or a total of five. Our circuit closures ranged from 3

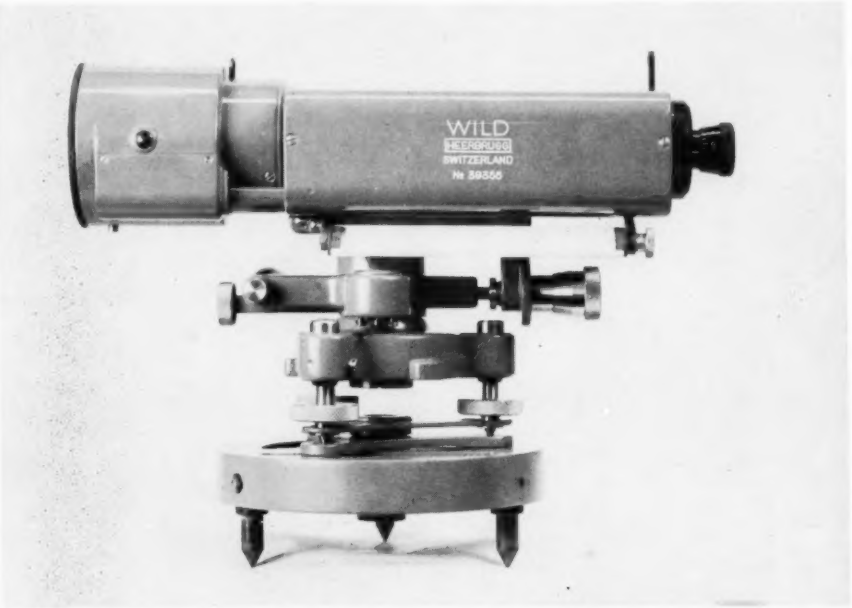

FIGURE 12.—Wild N–III precision level with optical micrometer.

set-ups and perimeter perhaps 300 to 350 feet, up to circuit closures of 12 or 13 hundred feet and 12 or 13 set-ups.

We closed, during the course of that project, something well over 200 circuits of leveling without a single rejection of any kind. The worst circuit closure in the whole business was 70-some hundredths of a millimeter, and the average circuit closure was more like 20 hundredths of a millimeter. Now, that is not a thousandth of an inch at 100 feet. But, on the other hand, it shows what modern leveling equipment is capable of doing if you pay attention to what is going on. We very soon found that we had to apply temperature corrections to our observed elevations because the walls of the building were going up and down with temperature changes on the order of 6 millimeters in a vertical distance of 11 feet. We had to set up in some of the most outlandish places you ever saw. There were times, when they were digging for the excavation of new underground structures, that the bench marks which were only 11 feet above the ground originally were another 20 feet above the ground when the rodman wanted to get to them. So we were not working under shop conditions by any means. In fact, I have some photographs, and some of the topography on the White House grounds is quite rugged. We obtained time movement profiles that show the movement in tenths of millimeters. We also were able to pick up the elastic rebound of the structure when they dug out the dirt for the basement and sub-basement.

MR. JENSEN: (National Bureau of Standards): There are a number of things that have been said here today that have impressed me very much. I was connected with some of the early work of Captain Reading in the standardization of the tapes and the bars that were used in the beginning of the work which led finally to the master tape that was produced by Mr. Keuffel. And I know something of the troubles that we had in trying to get precision. Also, I know what happened to at least one of the tapes after it was made by K & E. Apparently somebody did not know just how to use the tape and must have given it a terrific pull because one end of the tape kept its length and the other end of the tape was pulled out of shape. It was obvious that they needed a surveyor to discipline and manipulate the tape. Professor McNair brought up a question on which I feel very strongly; that colleges are not teaching their men how to measure. I see it all the time, either in surveying or in anything else. I hear so many reports of work that has been done by engineers and other people with college training indicating that they don't understand the first principles of measuring. They don't understand that if the mark that they are measuring is behind the crosshair, their crosshair is so large with respect to what they are measuring, that they can't possibly get the accuracy they are trying to get. People who are in ivory towers are talking about precision measurements, but they have not given the basic thought as to what is necessary to get that precision. They say we need a thousandth of an inch, but they have not thought out whether or not you can get a thousandth of an inch. They realize the problem when they are talking about 100 feet or 500 feet. They need some men like Mr. Rappleye to show them how to measure precisely.

As to whether these men are wanted in other fields, the answer is yes. I have been in touch lately with several manufacturers of large machine tools. They are interested in the problem. They are having to push their product to a higher precision, and they are interested in modern optical methods for precision measurement. People used to be taught precision measurement, but electronics and the fancy items have taken too much time, in my opinion.

PROFESSOR KISSAM: Thank you very much, Mr. Jensen. Unfortunately, we are overtime and we must end our discussion. This new development, I think, is of tremendous importance, of great interest, and requires a great deal of thought. Since I am a college professor, I can't miss the opportunity to say here and now that certainly we have got to teach the boys more surveying. Thank you very much.

What the Practicing Surveyor Wants in Surveying Education

By SOL A. BAUER

REGISTERED ENGINEER AND PROPERTY SURVEYOR, CLEVELAND, OHIO

TO ASK a land surveyor to tell his wants in education is a little like asking an Eskimo or a Hottentot to express his preference in olives. It is difficult to have a preference for something one has never had the opportunity to experience. It is possible that, in either case, the first taste might be a disappointment.

It is a surprising thing, however, that there is a marked and growing interest among land surveyors in the subject of education. The old school land surveyor was always rather proud of his practical experience and his freedom from book learning; he was proud of the fact that he carried the answers in his head and did not have to rely on books for his knowledge. But many of those men are now beginning to realize that education in the profession could be beneficial. Surveyors now can see the need for and want such an education.

A few of us land surveyors have talked around the subject for some time, with only mild conviction and no conclusions, since the opportunities for education in land surveying still appear to be very dim. Accordingly, no program has been even roughly defined, and I am therefore unable to speak for my fellow practitioners. Such opinions as I may express will of necessity be my own.

LOW MAN ON THE TOTEM POLE

To begin with, the most vitally needed educational prop for the land surveyor is, in my opinion, one that fortunately can predate the development of any land surveying curriculum. It can, and should, be immediately incorporated into existing civil engineering courses. That prop would be the inculcation of the idea among the faculty and students of civil engineering that surveying, including land surveying, is an honorable, important, and professional work. The entire surveying profession probably suffers more at the hands of our engineering schools than from any other one source.

For some reason, our civil engineering departments prefer to develop a caste system of importance within civil engineering. In one college structural engineering may occupy the throne; in another, sanitary engineering, or hydraulics; in another, soil mechanics, and so on; but in most, surveying is relegated to a low position. Personally, I am strongly opposed to caste systems, whether they be found in society or in education. I do not believe that the criteria that establish caste are sound or can be intelligently applied to groups. I am willing to admit superiority among individuals but hesitate greatly as between groups.

No one specialty can justly, or for very long, lay claim to a greater contribution to man's welfare than any other. It might well be argued that, fundamentally and generally, the surveyor and his works reach more widely into the warp and woof of our existence than almost any other form of engineering. But I would not press that argument too far, since it, too, is immaterial. It is particularly distressing, but true to caste systems, to find castes within castes and, unfortunately, the land surveyor in this country is apt to be "low man on the totem pole." Of course, if our colleges and educational institutions continue to refuse to supply an education to the land surveyor, then that specialty is apt to sink to a low status. I think it is rather remarkable that, considering the buffeting we land surveyors

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have taken in this country, our level of accomplishment is as high as it is.

If the surveyor, and particularly the land surveyor, is ever to be educated, his work and his efforts must be recognized on a footing equal with that of other branches of engineering. Unless such recognition is forthcoming, no educational curriculum for the surveyor will stand much chance. The development of an improved attitude toward surveying, as I have said previously, does not have to await the dedication of a college of surveying and mapping, but can start immediately. After we have created within our engineering colleges a respect for surveying as a field of endeavor, we might proceed to the curriculum itself.

THE SURVEYING CURRICULUM

In that curriculum, the usual basic science courses and mathematics should be required. The mathematics courses should extend through the theory of least squares and the law of probabilities. These courses are needed not merely for the sake of the practical applications involved, but rather to train the individual to reason mathematically and to create in him a scientific attitude toward the phenomenon of observation and the peculiarities of compensating error. There is probably more of pure science, or rather cold scientific reasoning and mathematics, necessary for the proper performance of surveying than in most other branches of civil engineering.

But the problem of the land surveyor is further complicated by the need to combine abstract, mathematical reasoning with reasoning of an almost opposite kind, the reasoning necessitated by the legal phases of land surveying—the ramifications of laws, statutes, and court decisions, and the vagaries of local customs and regulations.

There should be included in the curriculum rather extensive education in law, not only in the law of boundaries and titles, but also in other forms of law, so that the land surveyor may be able to reason logically from legal theory to sound conclusion. He should be familiar with the rules of evidence and sufficiently familiar with rules relative to interpretation of legal documents to be able to prepare and interpret descriptions of property and their allied documents. Of more importance than the mere memorizing of legalistic facts is the development of the ability to reason soundly in legal matters as they pertain to property surveying and its allied fields.

Education in the elements of logic should have an important place in the curriculum.

The land surveyor should have basic training in all branches of surveying, including geodesy, astronomy, photogrammetry, electronics, map projections, mapping techniques, hydrography, and so on. He should have some education in forestry and geology, and some orientation in geophysics. To repeat a thought I have presented previously, I believe that the land surveyor should be the general practitioner of the surveying field, with sufficient knowledge of the various specialties so that he would be familiar with their applications, realize his own limitations, and be able to coordinate the efforts of one or more specialists into his work, if so needed. He should, of course, like his brother engineer, attempt to develop into a well rounded individual so that he can take his place among his fellow men.

THE HUMANITIES AND THE SURVEYOR

There is a trend at the present time in engineering colleges toward what is called the "humanities." Whatever they are, or rather, whatever they are supposed to be, the land surveyor should benefit by them. At this point, permit me to digress to take exception to the manner in which this cultural program is sometimes attempted.

Most of us are engineers and/or surveyors because temperamentally and psychologically we are of the detail, rather than the executive, type. The two types are often antagonistic. But that does not necessarily mean that the detail man must spend the remainder of his life alone with his slide rule or calculating machine. He can, and often does, develop other facets that make him a well rounded, well adjusted, and generally competent individual. On the other

hand, he is not so apt to react readily to the same set of stimuli to which the extrovert or executive type would respond. The direction that the broadening aspects of his career might take is apt to be strongly individualistic, and therefore not so prone to be developed by mere exposure to a few stereotyped lecture courses on so-called humanitarian or cultural subjects.

Many years ago, when I was a college student, there was an attempt to broaden our outlook by means of a one-hour lecture course in economics. The course was taught by a fine, old gentleman, president-emeritus of the school, well over eighty years of age, practically deaf, very feeble, and unable to see beyond the first row. We learned nothing, of course, and developed the idea that economics was pretty silly stuff.

The humanities courses are often poorly or hurriedly presented, too completely removed from the rest of the curriculum, and too foreign to everything else to be more than a waste of time for which some less cultural, but probably more beneficial, engineering course has been set aside.

It seems to me that the best the engineering schools can do is to offer the opportunity to the student for development in other than strictly engineering fields by presenting the possibilities of other interests and the encouragement of their development. This could be done through extra-curricular activities and through stimulation by faculty members having outside interests of their own.

I was pleased to learn some time ago of a librarian of one engineering college who had interested a group of students in collecting musical records, and had thereby developed an enthusiastic group interested in good music. I believe that an activity such as that does far more to broaden the students than a dozen perfunctory lectures on economics, public speaking, and other subjects in which the students find no interest.

The curriculum that I should like to see would be more than just a matter of a specified number of courses and hours of study. It would be a period of educational and mental development. It might well occupy the full four years of a college course. I firmly believe that the field is important enough to warrant that much time. Our neighbors to the North have one such college at Laval University in Quebec. That college enjoys a high reputation.

THE JOB TO BE DONE

The problem of organizing a college for the teaching of land surveying would be no easy one. There are at least two centuries of prejudice to overcome. The surveyor himself might have many objections. The entire structure and practice of land surveying must be lifted to higher planes of endeavor and higher goals of achievement to insure sufficient demand to justify such an educational program.

But my experience with my professional colleagues over the past twenty years has indicated an accelerating rate of progress within the profession. The needs for surveying are increasing; the problems of surveying are becoming much more complicated; and surveyors across the country are beginning to feel their responsibilities more keenly. Our engineering colleges can promote the development, if they will, or they can continue to treat surveying, and particularly land surveying, as the stepchild of engineering. If the latter remains their course, the development will be retarded. It is my firm belief, however, that the development will go on, nevertheless. Prof. George Harding says that the solution is to strike out for ourselves and divorce ourselves from civil engineering. The United States Civil Service says we are all cartographers, and not engineers. There are many conflicting ideas for a solution. Whether any of these is right, the fact remains that surveying is too important a part of our existence to remain the unwanted, uneducated stepchild of our engineering institutions. In view of the extremely rapid progress that is taking place throughout the entire field of surveying and mapping at the present time, the job will be done, and it is to the benefit of all, certainly of all those gathered here, to work toward a greater recognition of the importance of this field.

Standards of Accuracy for Highway Surveys

By J C CARPENTER
BUREAU OF PUBLIC ROADS

"The road will be built as is, by eye."

THIS blunt decision was announced by a stubborn county commissioner in the early 1920's. He means that the county would not pay for transit-and-tape surveys and the preparation of plans. A horse-drawn blade grader would shape the road along its old location and there was no need of expensive engineering to build a highway.

Some of this sentiment has been carried down through the highway organizations to the present day. It was a natural consequence of the end of the dirt road era when graded earth was the prevailing type. The Federal-aid era was just beginning, and, with it, the development of highway engineering as a profession.

The Federal-aid Road Act of 1916 and the Federal Highway Act of 1921 required that each State should maintain at its own expense a State highway department. There were very few recognized State highway departments in 1916 and not very many professional highway engineers. Of course, the newly organized departments did not immediately appear with all divisions and personnel functioning efficiently. A highway engineer was considered to be little better than a good grading foreman. Some of them were of that type. The State highway engineer in one State was appointed on the sole qualification of having built excellent top-soil roads as a county road supervisor.

The original Federal-aid Acts stipulated that Federal-aid highway funds could be used for construction but not for surveys, plans, specifications, or estimates, which must be furnished by the State highway departments. This restriction was responsible for part of the many difficulties of the newly organized State highway departments. Funds were always insufficient. One department had only $10,000 per year to pay all of its operation costs. Counties were persuaded to provide the construction funds to match Federal aid. County commissioners who had been operating without the services of a highway engineer were likely to announce that the road could be built "by eye" when they were solicited to pay for surveys and plans. But some type of survey was always provided before the Federal-aid project was approved. As the State highway departments became better organized and more State funds were provided, the surveys improved in quality and the professional engineers in charge of highway department operations recognized the value of carefully made preliminary surveys.

Read by Comdr. J. E. Waugh, U. S. Coast and Geodetic Survey, at the Joint Highway Engineering and Surveying Conference, University of Florida, October 23, 1952.

HIGHWAY SURVEYS

Practically all highway surveys are now made as "force account" projects. Each department establishes its rules of operation and several have issued manuals for guidance of survey parties. Recently, due to the shortage of engineers, a few surveys have been made by contract but the practice is not common.

In the construction departments, where a large part of the work has been done by contract, standard specifications have been formulated for the materials and uniform specifications have been adopted for execution of the work. The Federal-aid Rules and Regulations require that construction work shall be performed by the contract method unless the State highway department and U. S. Commissioner of Public Roads find that the interests of the public will be better served by some other method. The specifications governing this work have been perfected through joint cooperation of Federal, State, and local engineers and the contractors.

As an example of the value of these speci-

A ROAD OF THE 1920'S

This graded and drained earth road, which was maintained with a split-log drag, adequately served the traffic of the 1920 period. No detailed surveys were required for its location or construction. Railway-location engineers were inclined to chide highway engineers with the statement "It's a derned good thing you fellows have the railroads so you will know where to put your highways."

fications, the commonly recognized material "sand" may be cited. Early practice in concrete for highways allowed the use of bank-run gravel for concrete in headwalls and small culverts. "Sand" was "most anything that is too coarse to put in spinach." As the volume and usage of concrete expanded, more attention was paid to the quality of the mineral making up the grains, the grading, strength, and other similar characteristics which construction practice had determined to be important. The specifications have been revised and improved through the years so that engineers who now specify "sand" may be sure that the material will be of the best quality.

Specifications for other materials used in highway construction have been perfected through this procedure. Surely no engineer will deny that the development of universally recognized standard specifications has resulted in economical and satisfactory construction.

Perhaps because highway surveys have been executed by the responsible governmental agency, and not by contract, there has been no apparent demand for a standard of accuracy, or specification. The cost of highway surveys as compared with the total expenditures of the highway departments is small. But the total mileage of surveys and resurveys required for each year's work is

reported to exceed 26,000.[1] Geodetic and cartographic engineers have expressed surprise that highway engineers have made so many surveys without a universal standard of accuracy. Transit-and-tape surveys are necessary to define the location, establish line and grade, and provide measurements for payment of work done. When the project is completed, the survey data has little value unless the work had been executed with standard accuracy and a permanent record is made of the adjusted information. Certainly it seems that surveys are as important as the sand that is used in concrete and that there should be a recognized standard specification to make them of maximum value.

SURVEY SPECIFICATIONS

In 1933 the Board of Surveys and Maps of the Federal Government approved and published specifications for horizontal and vertical control. These have become universally recognized as standard for control surveys to determine the latitude, longitude, and elevation of marked points in an area to be mapped. Conformance with these standards by geodetic and mapping agencies has resulted in a uniformly high quality of surveys. Recognizing the desirability of a similar specification for accuracy of highway surveys, the Highway Committee of the Control Surveys Division, American Congress on Surveying and Mapping, at the suggestion of Capt. H. W. Hemple, Chairman of the Division, prepared a proposed specification for highway surveys. This specification was designated "A Standard of Accuracy for Highway Surveys" and was accepted as preliminary for discussion and revision at the meeting of the Control Surveys Division, June 9, 1949. These specifications were published in SURVEYING AND MAPPING, October–December 1949.

The preliminary Standards of Accuracy were widely distributed to highway engineers throughout the United States. Through the Operating Committee on Design, of the American Association of State Highway Officials, we received valuable suggestions from members representing forty State highway departments. The specifications were carefully reviewed by the Committee on Standards of the Division of Control Surveys. Using all the suggestions and recommended revisions received in a two-year period, the original standards were revised and reissued by the Highway Committee as "A Policy on Highway Surveys." The Committee on Highways presented the "Policy" at a meeting of the Division of Control Surveys, June 18, 1951, and it was approved. On June 20 the American Congress on Surveying and Mapping adopted the "Policy" and, by resolution, urged the American Association of State Highway Officials to adopt this specification as a standard for highway surveys. The "Policy on Highway Surveys" with supplemental resolution, as finally approved by the American Congress on Surveying and Mapping, appears in the October–December 1951 issue of SURVEYING AND MAPPING.

In urging the use of this policy by highway engineers, the most frequent objection encountered is that any improvement in accuracy will increase the cost of their surveys. No evidence has ever been presented to show that costs will be increased. It is not expected that every measurement made from reconnaissance through the final survey shall comply with the strict requirement of the specifications although it is anticipated that there will be a general improvement in the quality of all survey work as the engineers continue to use the policy. But it seems logical that, through checking, rechecking, and final adjustment of the results, the ultimate accuracy attained should be equal to or superior to that specified in the policy. Of course, the measurements made during the final survey after completion of the project should be of highest accuracy. They will be made on completed pavements or subgrades where uniformly good taping conditions prevail, and angle measurements can be repeated as many times as is necessary. Final elevations of

[1] "Photogrammetry as Applied to Highway Engineering" by Jon S Beazley, *Photogrammetric Engineering*, Vol. XVII, No. 1, March 1951.

bench marks and important points on the highway may be accurately checked and adjusted.

THE "POLICY"

The "Policy" states that "(1) planning of survey operations, (2) reasonable attention to field practice, and (3) preservation of records, are essential to attainment of the accuracy of these standards."

The "planning of survey operations" may well include a careful study of all procedures from the initiation of the project through the reconnaissance, location, construction, and final survey. It is not proposed to give here any of the details of the survey procedure. Reference may be made to Lloyd J. Morrison's article, "Highway Location Ground Surveys in National Forests and Parks," in SURVEYING AND MAPPING, October–December 1949. One of the important features of a survey is the tie to the geodetic network. The policy proposes that "where available within reasonable economic range, points with known adjusted positions shall be tied in to the highway survey and used to check its accuracy. State standard plane coordinates shall be used to establish the location of points on the highway survey, whenever possible." In the planning of any survey a thorough review of available control should be instituted and, if it is found that control points are available within economical reach of the survey, the plane coordinates may be obtained and furnished to the survey party. Geodetic survey triangulation points are the best for control for they have been located with a high degree of accuracy, and reference and azimuth marks are available for use by the local surveyor. Plane coordinates have been computed for all adjusted points.

Where topographic quadrangles have been mapped by the United States Geological Survey, data from the traverses or triangulation used as control may be obtained from that agency. This is usually third-order. H. D. Walker's article, "Third-Order Surveys at Reasonable Cost," in SURVEYING AND MAPPING, July–September 1952, is an excellent description of the traverse surveys of the Geological Survey. It should be read by all highway engineers. The traverse points set by the Geological Survey may be used as temporary control for highway surveys. The locations are expressed as geographic coordinates, that is, degrees of latitude and longitude, except for some of the more recent surveys, where plane coordinates are also given. The conversion from geographic to plane coordinates for these locations may be easily accomplished through the regular Coast and Geodetic Survey formulas or the interpolation method of the Geological Survey. In using these points as control, it should be remembered, as is pointed out by Mr. Walker, that "the traverse must be accurate enough so that errors are within the plotting accuracy." This control will provide an approximate location for establishing the plane coordinate grid, but before using the plane coordinates for record purposes they should be adjusted through ties to geodetic triangulation stations. The use of the Geological Survey's control traverses as a basis for a highway survey will allow the coordination of the highway alignment and grade with the contours on the quadrangle map and should prove to be a valuable aid in checking the highway location.

"Reasonable attention to field practice" may involve the coordination of survey operations so that the work done in one phase may be used as a check in the next operation as, for instance, between the location and construction surveys, and for the checking of all revisions and equations so that they may be adjusted for the final survey. It has been established through actual timing of operations that any good instrumentman can make six pointings, three direct and three reverse, and read the third angle as a check, within a four-minute period. The requirement of at least two readings for third-order accuracy will not unduly delay the work or require any additional personnel. Chainmen soon become expert in the use of the spring balance and plumb-bob and in reading temperatures. The

practical suggestions given in Mr. Walker's article should be applied to highway survey procedure.

"Preservation of records" will involve the filing of an "as built" set of plans which will be the result of a final survey and adjustment of all information obtained in previous surveys. Horizontal positions should be indicated by plane coordinates, wherever practicable. Bench mark elevations should be established after adjustment of all level lines run during the life of the project and should be referred to the sea-level datum. The widely extended network of vertical control, as established by the U. S. Coast and Geodetic Survey and the Geological Survey, will soon provide standard bench marks within easy reach of practically all highway survey projects.

The three general requirements, careful planning of survey operations, attention to field practice, and preservation of records, will not increase the cost of survey operations as now performed by a State highway department. No additional personnel will be required and the time required for field surveys will not be extended. There will always be need for replacement of worn out instruments and equipment and it is entirely probable that, with some attention to accuracy, the equipment purchased may save time and party expense.

A MODERN EXPRESSWAY IN CALIFORNIA

The complicated alignment of the interchange requires the use of a coordinate scheme for design and construction. Accurate surveys are essential for satisfactory development of this type of highway alignment. *See* G. M. Leatherwood's article, "Application of Coordinate Methods to Freeway Planning and Construction," *California Highways and Public Works*, November–December 1946.

In the long run, compliance with the proposed policy will result in a reduction of the cost of surveys. Departments that follow the procedure as recommended will establish a rapidly growing record of accurately located highway control points which will mean that important decisions may be made without the necessity for field surveys. There can be no doubt as to the value of a horizontal control system which is provided by the geodetic network of triangulation and traverse points of known plane coordinate position nor of the utility of bench marks whose elevations are referred to mean sea level. Sea-level datum for levels is used by all engineers when bench marks can be found within economical reach of the survey. The use of horizontal control through State plane coordinates will be accepted as standard practice as soon as the control points can be reached without undue increase in the cost of the survey.

Highway engineers make checks of their work as they proceed. When a curve is staked the deflection angle between tangents is checked and adjustments made. The policy recommends additional tests for accuracy which will show up any errors or blunders not ordinarily found through checking methods now in use. The satisfaction of having completed a survey which meets the specification established in the policy will provide a psychological value for a surveyman which will eventually pay off in dollars saved through more efficient work. In court cases the record of a check of accuracy against universally recognized basic data will establish the quality of the survey data and serve to convince the court that the engineers are professional experts. The use of plane coordinates to describe land boundary monument locations provides an accurate supplement to the calls usually included in right-of-way deeds. In twenty-five States the coordinate systems are recognized as the legal method of description. The highway departments in these states should certainly use the coordinates in their right-of-way deeds, and in the other twenty-three they can encourage the adoption of this method by using the coordinates in field survey operations.

HISTORY OF THE "POLICY"

The Highway Survey Committee of the Control Surveys Division was made up of practicing highway engineers. The original "Standards of Accuracy" were prepared, after a canvass had been made of all committee members, by the writer and William T. Pryor, with the assistance of Capt. Henry W. Hemple, Chief, Division of Geodesy, and L. G. Simmons, Chief Mathematician, both of the Coast and Geodetic Survey. The text was reviewed and revised as to technical requirements by the Committee on Standards of the Division of Control Surveys under the Chairmanship of R. M. Wilson, Chief, Geodesy and Control Surveys Section, U. S. Geological Survey. The original Standards were circulated to members of the Design Committee of the American Association of State Highway Officials and on December 6, 1950, Jon Beazley, a member of the Highway Committee of the Congress, appeared before the Design Committee of the Association of State Highway officials, explained the Standards, and answered questions of the committee members.

Comments were received from forty members of the Design Committee of the Association of State Highway Officials. Twenty-two of these endorsed the proposed standards without reservation, six suggested a different classification of the importance of highways, three agreed that the standards are desirable but they cannot apply them at once, and one indicated that his State is using higher standards than those proposed. Thirty-two were in favor of the proposed standards. Eight members did not recommend approval of the standards. The reasons given for disapproval were (1) the accuracy suggested would increase survey costs out of reason, (2) the accuracy prescribed is not necessary and there are already too many standards, (3) the accuracy is entirely too high and cannot be justified, and (4) "we are not convinced at the present time that the standards proposed will help to

produce the best system of highways but consider the standards not too rigid for adoption at a later date."

The original standards were revised to include all desirable provisions suggested through this method of discussion. The revised text was endorsed without recommendation of revision by all members of the Highway Surveys Committee except Mr. Pryor. He suggested an alternate wording for the specification for leveling which is printed as a footnoote on the approved "Policy."

The American Congress on Surveying and Mapping presents this "Policy" to highway engineers as a workable standard specification which will improve the quality and provide permanent value for surveys. It is a practical usable standard which we hope will be adopted and followed. In this discussion the value of more accurate surveys in highway engineering has been the sole topic. Accurate surveys based on plane coordinate control will be of much value to other engineering activities in which the highway is usually the central artery. Imagine the saving in expense to land surveyors, irrigation and drainage engineers, topographic mapping, and similar pursuits if all the public highways were surveyed with minimum modified third-order accuracy and monuments along the highways were available for public use. However, highway administrators are always sensitive to the fact that public funds are provided to build and maintain highways to serve the travelling public. Any expenditure of funds beyond this requirement, such as for geodetic surveys, might be criticized as improper use of funds. The "Policy" does not suggest that highway surveys be made with geodetic accuracy. It does prescribe the accuracy which will be most suitable for highway purposes and which will result in efficiency and economy in highway engineering operations.

Specifications and Use of Topographic Maps in Highway Work

By L. L. FUNK

DISTRICT V, CALIFORNIA DIVISION OF HIGHWAYS

REQUIREMENTS for the planning and design of modern turnpikes, freeways, and expressways go far beyond the old concepts of highway location under which it was considered to be a form of route surveying. The major importance of such highway facilities and their influence on the traffic pattern and economic life of entire communities place their location beyond the scope of any one man's abilities. The highway locator has, to a great extent, been replaced by a staff of experts specializing in such fields as traffic, community planning, highway design, right-of-way, and construction.

Final selection of the route of an arterial highway frequently involves concurrence of several governmental agencies and may require discussions before local civic organizations and other groups. Even after the general location is determined, it is often necessary for the more important features of the design to pass through many hands before they are finally incorporated into construction plans.

MAPS—ESSENTIAL TOOLS IN ROUTE SELECTION

Maps, and particularly topographic maps, are the basic indispensable tools required for all such studies, discussions, and presentations. The problem confronting the highway engineer is not whether maps are necessary but rather the type to use and how to obtain them.

For preliminary studies and general route selection, the necessary maps may take the form of aerial photographic prints or mosaics, or they may be planimetric maps. Topographic maps are generally desirable and under certain terrain conditions they are essential. For some projects, the modern 7½-minute quadrangle sheets at 1 : 24,000 scale with 10-foot or 20-foot contours are ideal.

Unfortunately the areas covered by such mapping are all too few. The American Congress on Surveying and Mapping is thoroughly familiar with this problem through various papers in SURVEYING AND MAPPING and through the excellent work of the Committee on Topographic Mapping for Highway Location. It is a subject important enough to bear repetition.

In California, thanks to cooperative agreements between the Department of Public Works and the U. S. Geological Survey and other Federal agencies, and to the many critical defense areas and military reservations, the coverage of standard quadrangle sheets is more complete than in most States. However, there are still many areas not covered by such mapping where topographic maps are needed for highway location studies. During the past few years the California Division of Highways has awarded several contracts for contour maps, compiled by photogrammetric methods, at scales of 400 feet and 500 feet per inch with 10-foot and 20-foot contour intervals, for use in preliminary studies.

As a high degree of accuracy is not required, the specifications for such work are not as rigid as for larger scale maps which are to be used in the final design of the highway. Third-order horizontal control is usually specified and, if practicable, the use of the California Coordinate System is required. Specifications are generally broad enough to allow the contractor to take full advantage of his stereoplotting equipment in bridging control. We have, in the past,

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specified that 90 percent of the contours be within one-half the contour interval. Some saving might be made by reducing this to 60 percent or 75 percent for such preliminary maps, as accuracy is not essential. When the ground is obscured, we modify the contour accuracy to half the height of the ground cover.

After the general location of the highway has been selected, a topographic map is an absolute necessity for the final positioning of the centerline and for the layout and design of interchange facilities and connections. The map may be obtained by the conventional transit, tape, and cross section method, by plane-table survey, by photogrammetric methods, or by a combination of these methods. As a general rule, the principal limitation on the use of aerial surveys for the final location and design of a highway is the extent to which the ground is obscured.

As compared to the average road of a quarter century ago, which could generally be fitted into a 60- to 80-foot right-of-way, the modern freeway requires a width ranging from 200 feet to 1,000 feet or more at interchanges and connections. To insure proper positioning of the highway and its appurtenances, the designer should have a topographic map considerably wider than this minimum requirement. This factor of width weighs heavily in favor of the aerial survey as a method of obtaining the map.

AERIAL SURVEYS FOR CALIFORNIA HIGHWAY DESIGN

In California there is a definite trend toward the use of large-scale topographic maps made from aerial surveys for the location and final design of highways on new location or where considerable relocation is involved. In District V of the California Division of Highways, located in the coastal area between San Francisco and Los Angeles, well over half of the surveys made during the past two years have been made by photogrammetric methods. These have included two contracts totaling $73,000, which provided for the following mapping:

Lineal Miles	*Scale (Feet per Inch)*	*Contour Interval (Feet)*	*Average Cost per Mile*
26	50	2	$1,550
12	100	2	$1,210
9	100	5	$ 935
15	400	10	$ 485

The 400-feet-per-inch mapping covers an area between 1 and 2 miles in width and will be followed by a separate contract for large-scale mapping after the general location is definitely determined. The 50-feet- and 100-feet-per-inch mapping ranges in width from 500 feet to 2,000 feet. The construction and right-of-way costs for the sections of highway covered by this large-scale mapping will be in excess of twenty-five million dollars. The topographic mapping involves less than three-tenths of one percent of the total cost of the projects.

In general we prefer the 50-feet-per-inch scale with 2-foot contour interval for freeways and expressways, particularly in urban areas. For secondary roads in rural areas, and in mountainous terrain, the 100-feet-per-inch scale with 2-foot or 5-foot contour intervals is satisfactory. If additional working space is required on the maps, they are enlarged photographically to 50 feet per inch. The contour interval is definitely governed by the terrain and unless there is considerable slope to the ground the 5-foot interval is not satisfactory for final design work.

Our administrative regulations require that all aerial survey work be awarded on the basis of competitive bids. In order to insure maps of the necessary accuracy, the specifications must clearly define the end product desired and protect the Division of Highways from irresponsible and incompetent bidders. To attract favorable proposals from reliable mapping organizations, they must also protect the contractor and not impose restrictive limitations on his usual method of operation. We consider that we have been successful in these objectives at least in our larger and more recent mapping projects. The first of the

two contracts previously mentioned was awarded to Fairchild Aerial Surveys and the second, now in progress, is being carried out by Lockwood, Kessler and Bartlett.

We do not consider it desirable or feasible to require specific equipment or to write a rigid specification as to methods of procedure. As a means of evaluating proposals submitted and to have some measure of control over the contractor, we require a statement accompanying the proposal showing experience in similar work, evidence of financial responsibility, equipment proposed for the project, and scales, operating ratios, and methods of procedure to be used in various phases of the work. This statement also describes the methods to be used in making the necessary ground control surveys, specifying the accuracy proposed for intermediate control and the extent of horizontal and vertical control proposed for each model.

SPECIFICATIONS FOR MAPS USED IN HIGHWAY DESIGN

For large-scale topographic maps to be used for final location and design, our specifications for accuracy conform to National Map Accuracy Standards. Modifications of the tolerances for accuracy of contours where the ground is obscured must be considered separately for each project and must be clearly defined in the specifications. If the areas involved are minor, no modification is permitted and ground completion surveys by the contractor are required. In large areas where there is some doubt as to whether accurate contours will be required for design work, a tolerance of half the height of the ground cover is specified. If the information is found to be necessary at a later date, we will obtain it with our own field parties.

Planimetric detail to be shown on the maps includes roads, railroads, fence lines, utility poles, billboards, boundaries of timber and brush areas, free-standing trees, and any other distinguishing features or improvements which are visible on the aerial photographs. All buildings are generally required to be shown whether visible on the photographs or not.

In both the planning and preparation of specifications for a mapping project we attach particular importance to the ground control survey. As a general rule the control points required by the mapping contractor for establishment of map control are not sufficient in number or properly located for our future requirements. We have found it generally advisable to have monuments at intervals of 1,000 to 2,000 feet in urban areas and not more than one-half mile in rural sections. The monuments may be arbitrary points or may be existing property corners or street or subdivision monuments. The location of these monuments is carefully planned; they are shown on the maps accompanying the contract and the mapping contractor is required to establish their true position during the course of his ground control survey.

Standards of horizontal accuracy for ground control surveys conform to the "Policy on Highway Surveys" prepared by the Control Surveys Division of the Congress. According to this Policy, modified second-order accuracy shall be used for expressways or other four-lane facilities. The Policy definition for error in length measurements of 1 in 10,000 is satisfactory but we do not feel that the error in angular measurement of 20 seconds times the square root of the number of angle points, as proposed by the Policy, is acceptable for this type of work. It would be perfectly satisfactory for the final location line, as tangents for this type of highway usually have a minimum length of 1,500 feet. But for an arbitrary control traverse which might have ten or more angle points per mile, we prefer to specify the originally proposed tolerance of 20 seconds per mile.

We realize, and are frequently so advised by mapping organizations, that third-order accuracy is sufficient for photo control in the production of maps to the specified standards. However, we plan to utilize the contractor's control survey as the basis for the final centerline and all subsequent sur-

veys on the project. To insure accuracy of the final centerline which will be monumented and will serve as a permanent extension of the control network, we believe that the slight additional cost of second-order work is a good investment.

The mapping contractor is required to base his primary control survey on first- or second-order stations of the U. S. Coast and Geodetic Survey, to adjust his surveys by standard methods, and to furnish the position of all control points and monuments expressed in terms of the California Statewide System of Plane Coordinates. In addition to this, he is required to furnish the original survey notes and all calculation sheets showing both measured and adjusted angles and distances. The monuments, control points, and coordinate grid are required to be shown on the topographic maps with an accuracy of the nearest 0.01 inch.

The extent of the vertical control to be established will vary with the individual project. As a general rule we are quite fortunate in having a level line of the U. S. Coast and Geodetic Survey parallel or closely adjacent to most projects. In such cases we will establish our own bench marks prior to construction and our mapping specifications require that vertical control points set by the contractor be accurate to within one-tenth the contour interval.

Spot elevations, determined photogrammetrically, are required at saddles, tops of summits, bottoms of depressions, and road intersections. They are also required along the edges of the area to be mapped if the terrain is comparatively level and no contour is within 150 feet of the edge of the area. Where the contour interval is 2 feet, we specify that the spot elevations shall be expressed to the nearest 0.5 foot and accurate within 1 foot.

CHECKING THE MAP

The checking of a mapping contract of this kind is often a difficult problem. The extent of the problem is largely dependent on the competence and reliability of the mapping organization. As we have the original field notes and the calculations of the adjustments, checking of the ground control survey is largely a matter of office work. An observer usually pays occasional visits to the field survey party to familiarize himself with the notes and the methods used. Cultural detail is checked by inspection with occasional spot checks for accuracy.

Contours are checked by the usual profile method. Specifications provide that no map sheet will be rejected for inaccuracy of contours unless profiles totaling at least 26 inches in length at the map scale and crossing a minimum of 20 contours show that it fails to meet the specified requirements. Our latest contract provides that if a map sheet is checked, revised by the contractor, and then rechecked and found to be still outside the specifications, the cost of the rechecking and all subsequent checks will be assessed against the contractor. Before using this clause we contacted several mapping organizations and found the reaction generally favorable if we could guarantee that our field checks would be accurate. To protect the contractor in this regard, we added the provision that the profiles would be based on a closed traverse and closed leveling between points which can be readily identified on the map.

The extent of the checking is entirely dependent on the engineer in charge of the project. To any highway organization contracting for mapping of this type for the first time, we would recommend rather extensive checking. It will satisfy the designer that accurate topographic maps can be produced by photogrammetric methods and will give him a feeling of confidence in the maps that he could not obtain in any other way.

VALUE OF GOOD MAPS

On projects where we have obtained large-scale topographic maps from aerial surveys together with an accurate well-monumented control network, we find it necessary to do very little survey work with our own field parties prior to award of the construction contract. The necessary prop-

erty-corner ties are made from the monumented control points at the time the maps are field checked. The projected centerline is then calculated and deeds are written based on these ties. On several projects which we are now designing, the final centerline will not be staked in the field until buildings and other obstructions have been cleared from the right-of-way immediately prior to construction.

We have found that the use of aerial survey methods as described has resulted in substantial savings in time, money, and manpower. They also have the advantage of bringing our survey network into the California State-Wide System of Plane Coordinates. Following official adoption of this system by the Legislature in 1947 the California Division of Highways adopted a policy of using it whenever practicable and instructions were issued that our existing survey network should be gradually converted to the Coordinate System. This will require a long period of time but some progress is being made, particularly in areas where existing primary control stations are closely spaced.

On projects where aerial survey methods are practicable, the network can be extended from distant stations more accurately and efficiently by a mapping contractor's control survey party than by the average highway survey party which has neither the equipment nor the experience necessary for this type of work. The value of an expanded system of supplemental control along major highways has been discussed too many times to require repetition here.

This paper has attempted to stress the importance of topographic maps in highway location and design wtih particular emphasis on the advantage of photogrammetric methods for obtaining the maps. The highway engineer engaged in the planning and design of a modern highway is very definitely a customer of the topographic mapping profession. Failure to realize this and to understand the nature and necessity of this essential tool may result in an improperly planned highway facility and an increased cost amounting to many times the value of adequate topographic maps.

Reprints of Articles

Reprints in quantities of 50 or more may be obtained of any article appearing in this issue. Orders must be placed with the Editor-in-Chief, Robert C. Eller, Topographic Division, U. S. Geological Survey, Washington 25, D. C., not later than 3 weeks after publication. Authors who wish reprints of their articles may so indicate when manuscripts are submitted. Approximate prices of 4- and 8-page reprints follow:

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Surveying and Mapping Methods Peculiar to Northwestern Forest Areas

By JAMES FRANKLAND

REGIONAL ENGINEER, U. S. FOREST SERVICE (RETIRED)

THE Pacific Northwest Region of the U. S. Forest Service, comprising 19 National Forests and 27 million acres, contains many variations of topography, climate, and vegetation. The lush and densely timbered coastal section, the rugged Cascade Mountains, and the high, semiarid, sage-brush-covered plateau of eastern Oregon and Washington each present different situations which must be faced when mapping problems are to be considered.

Because time and money are big factors in mapping these difficult areas, new and better means of carrying on an economical mapping program are continually being sought. This work is the responsibility of the Surveys and Maps Section of the Division of Engineering. Although this Section is comparatively small in manpower and equipment, it has kept up with the mapping needs of the Region by using photogrammetric methods for both planimetric and topographic mapping.

It has been the practice in this Region to prepare topographic maps of timber-sale areas in order to plan the operations and to facilitate administrative and resource management. With the demand for increased timber production after World War II, faster methods were required to keep up with the timber-sale business.

Although the Forest Service is an accepted mapping agency of the Federal Government, it is not primarily a mapping organization. For this reason its mapping activities have been carried on with relatively inexpensive equipment and with a small staff. As a result, the Forest Service has been a leader in the design of simplified stereoscopic plotting machines and techniques for the production of maps from aerial photographs. The Pacific Northwest Region pioneered in the development of low-cost precision photogrammetric equipment, to a large extent through the efforts of Lage Wernstedt, now retired, who developed the principles embodied in the plotting machines in use today by the Forest Service and a number of other agencies.

VERTICAL CONTROL METHODS

The use of these machines for mapping topography depends on vertical control points in individual stereoscopic models. Until recently, the only accurate means of obtaining vertical control data was by spirit leveling, trigonometric leveling, or plane-table mapping.

Early in 1945 the Chief of the Forest Service called attention to the newly developed Wallace & Tiernan aneroid altimeter. Tests were run with a few of these instruments and other altimeters of different make over a course of bench marks near Portland, Oreg. Results were encouraging enough so that five more tests were run—two over the course just mentioned, one in southwestern Oregon, one on the divide of the Blue Mountains, and one in Ochoco National Forest. Every effort was made to follow the procedure outlined by Prof. Philip Kissam of Princeton University in his article, "Precision Altimetry," published in Photogrammetric Engineering, Vol. X, No. 1, 1944.[1]

It was concluded from the 1945 tests that these altimeters were capable of producing

Paper delivered at the annual meeting of the American Society for Engineering Education, Committee 8, Surveying & Mapping, at Seattle, Wash., June 20, 1950.

[1] *See also* "Altimetry—Its Present-Day Techniques," by Lester E. Demler, SURVEYING AND MAPPING, July–Sept. 1951.

results acceptable for establishing vertical control data for photogrammetric mapping with a 50-foot contour interval. This method is ideally suited to the rugged, heavily timbered areas existing in this region. Subsequent mapping completed primarily with the aid of these instruments for establishing vertical control has more than justified these earlier conclusions.

Briefly, the altimeter consists of a beryllium-copper capsule and a curved rack and pinion for communicating the capsule motion to the indicator. The dial is graduated in 10- or 20-foot intervals and each dial is individually calibrated at the factory according to *Smithsonian Meteorological Table 51, 5th Edition.* To avoid negative values, the zero on the altimeter corresponds to minus 1,000 feet in *SMT 51.* A set screw in the dial permits adjustment of the indicator so that one instrument may be made to agree with another, although in practice this is not necessary. There is no apparent backlash requiring "tapping." Parallax is avoided by a mirrored ring surrounding the dial which permits the operator to place his eye so that the indicator and the image are in coincidence before reading. The entire unit is mounted in a shockproof metal or hardwood case and is equipped with a padded carrying case for easy handling. With just a little practice the instrument can be read to 1 or 2 feet.

The accuracy of the type of contour map under discussion is such that not less than 75 percent of all identifiable points shall be within half the contour interval. In contrast to elevations determined by transit, level, or alidade surveys, where each individual elevation is affected by the accuracy of the circuit closure, each altimeter elevation is the result of independent observa-

A TYPICAL FOREST AREA OF THE PACIFIC NORTHWEST

tions and an error in one elevation will not be carried forward to involve another. Experience indicates that the majority of elevations taken with altimeters according to the proper procedure will be correct to within 5 feet, although a few will be in error up to two or three times this amount. To minimize the error, it has become normal practice to obtain a few more than the minimum number of elevations required to level the stereoscopic model, since the additional cost is slight and the plotter operator can average a number of points rather than take the chance of going wrong with the bare minimum. It has been learned that the best results can be expected when all altimeters being used on a project are kept within an area of 25 to 30 square miles. Occasionally this limitation is exceeded if optimum conditions exist.

The most accurate method of securing altimeter elevations is the "two-base" method requiring that two altimeters be located on bench marks at vertical extremes of the project and be read simultaneously by having all watches synchronized. Any number of roving altimeters can be used and more economical results are obtained by using the maximum number. Readings obtained from the roving instruments are proportioned between the readings obtained from the two "base" instruments to obtain elevations. It has been found that roving instruments used at elevations above the high-base instrument or below the low-base will not give results of acceptable accuracy unless the "single base" method is used.

In actual practice in this Region, the two-base method cannot always be economically used because most bench marks are established along roads and highways generally located in the lower valleys. The two-base method would require that an accurate bench mark be established at the highest point of the project, but this can be very costly, so the single-base method is employed where it is believed that it will give sufficient accuracy.

Inasmuch as instruments of this type are actuated by atmospheric pressure, it follows that in order to obtain the best results, observations should be made only on days of stable weather conditions and in the same drainage area. High or gusty winds will yield erratic readings.

The cost of these operations would be considerably reduced if a recording altimeter and hydrothermograph of the same accuracy as the present instrument would be developed to record the observations at the base stations while the field instruments are being carried to various points. This would do away with the present necessity of having a man do the very important but monotonous job of reading the base instrument. Correspondence with the Wallace & Tiernan Co. indicates that an instrument of this nature called an "alticorder" will probably be commercially available in the near future.

In the heavily timbered areas in which most of our topographic mapping projects are located, it is sometimes very difficult to identify the exact point on the aerial photograph at which the altimeter elevation is observed. In steep terrain an error of only a few feet in the horizontal location of the station may cause sufficient error in vertical placement to exceed the tolerance for the type of mapping being done. Because of this fact, it is necessary to use in this phase of the work well-trained personnel who have had considerable experience in field identification, so that identification errors will be reduced to a minimum.

As in other types of survey work in relatively inaccessible areas, the cost of a project depends largely on the time required to visit the necessary survey stations. Where long journeys on foot or horseback over steep terrain are required, costs mount quickly and men tire and do less efficient work. The helicopter has been recently used by various agencies to transport men and supplies in and out of such areas, and its use may eliminate a large part of this costly and arduous work. The U. S. Geological Survey has reported excellent results with the helicopter in topographic mapping projects in Alaska, as has the Topo-

THE DENSE FOREST COVER OF THE NORTHWEST HINDERS PHOTOGRAMMETRIC MAPPING

graphic Division of the British Columbian Surveys and Mapping Service. Within the Forest Service the helicopter has been used with success in transporting men and supplies to and from fire lines in California.

HORIZONTAL CONTROL METHODS

Preliminary tests have been made in this Region to use the helicopter as a direct aid to triangulation. Horizontal control for mapping in the Pacific Northwest is established almost entirely by triangulation. This is in contrast to certain areas east of the Rocky Mountains where traverses are run in the flat or gently rolling terrain. Because of the mountainous nature of our country, it is possible to erect intervisible signals in almost any desired locality or to "three-point" a station from already established triangulation stations. Within the National Forests and on adjacent State forest land, many fire-control lookout towers have been tied in to the triangulation network and they serve as excellent signals for any triangulation project. One of the difficult and more expensive parts of the operation is the building of signals on intermediate points, to be cut in by triangulation from lookout towers and other accessible stations. This work usually requires a separate crew or delays the actual triangulation until signals are in place in treetops or on open points. In the California Region of the Forest Service one such job was materially facilitated by dropping the signal-building materials to the vicinity of the station by airplane.

Tests have been made to substitute the helicopter for the signal by observing on the hovering "egg-beater" when over the station, thus eliminating the signal-building entirely in certain inaccessible places. In the fall of 1949, arrangements were made to use an Army helicopter and pilot for these tests. Observers from the Forest Service with transit and shortwave radio were stationed at various points at Fort Lewis, Wash. The helicopter was flown over each station and when the pilot gave a signal by radio, each observer read the angle observed through his instrument. The results of these tests were not as good as expected because of weather conditions which caused the helicopter to drift while hovering over the stations. They were, however, more encouraging than the first, but very brief, attempt in 1947. It is planned to make further tests under more ideal conditions later.

On one occasion Wallace & Tiernan altimeters were used in an airplane to obtain elevations in a rugged inaccessible area in the Mt. Baker National Forest of this Region. The airplane was flown level with the points for which elevations were required and the altimeter was read by the observer at a signal from the pilot. In this way, in an hour and a quarter flying time, elevations of sufficient accuracy were established to complete control for a topographic mapping project that otherwise would have required a 3-day pack trip by three or four men. From this experience it seems probable that the same thing could be done with a slow-flying or hovering helicopter with an accuracy sufficient for contour intervals of 50 feet or more.

TRAVERSE METHODS

In photogrammetric mapping, particularly in densely timbered areas, certain features will not show on the aerial photographs. This is particularly true of roads through forests. Furthermore, unless the photographs being used are of very recent date, there are apt to be important cultural features that do not appear on the photographs. In the past, the accepted way to obtain accurate information regarding these deficiencies was to rephotograph parts of the area or to run costly traverses with compass and chain or transit.

This situation has recently been remedied by the use of an odograph, built by the International Business Machine Corp. and the Monroe Calculating Machine Co. for the Army. This instrument draws, mechanically and automatically, a traverse of the route traveled by the vehicle in which it is mounted. The driver can stop at any time and mark in other features that do not show on the photographs. The instrument consists of a magnetic compass so compensated that the metal of the vehicle in which it is mounted (in this case an Army jeep) does not affect its ability to determine magnetic north. The compass is connected to a mapping table and controls the direction of a pencil which is moved across a sheet of paper, tracing the route traveled by the vehicle. A cable connection with the jeep driveshaft correlates the motion of the pencil with the distance traveled by the car. The instrument can be set to give a wide range of mapping scales.

The traverse drawn by the odograph is tied in to existing photography by identifying on the aerial photographs the beginning and intermediate points along the route traveled. The important drainage, road intersections, section-line crossings, buildings, and other features are spotted on the traverse sheet by hand during the course of the traverse. If the preliminary manuscript of the map has been previously prepared, traverse work can be combined with a field edit.

During the summer of 1949 the odograph was used to traverse 1,138 miles of road at a cost of approximately $4.00 per lineal mile applied to the manuscript, not including depreciation of equipment. This cost is very reasonable and considerably less than that required for a two-man crew running traverse on foot. The greatest gain is in the area that can be covered by odograph in comparison with ordinary traverse methods. The odograph averaged 1.2 miles of traverse per hour of driving time in 1949. As the roads traversed with the odograph were often widely separated, a large portion of the time was spent getting from place to place. The crew drove the odograph over 12,000 miles in order to traverse the 1,138 mile previously mentioned. It is believed that the odograph is an important part of the Region 6 mapping equipment.

SMALL-SCALE PHOTOGRAPHY

Another method has been investigated and used in a number of places in the interest of reducing costs of aerial survey work. This involves the use of small-scale photography in order to reduce to a minimum the amount of field control needed to control the photographs and then using large-scale photographs for the detail, transferring control points from the small-scale to large-scale photographs. Based on tests that were completed by this Region in 1945, it became evident that considerably more than the cost of the additional small-scale photographs could often be saved in the elimination of the ground control that would otherwise be necessary to control the large-scale photographs.

These are some of the rather unusual activities in which Region 6 has been engaged in connection with its photogrammetric mapping. It is believed that there will continue to be a challenge to the photogrammetrist to find new and cheaper methods of extending control and producing topographic maps required for the administration of our forest areas.

Land Survey Problems in the Florida Keys

By JOHN P. GOGGIN, P. E., R. L. S.

MARATHON, FLORIDA

A PROPERTY SURVEYOR will no doubt find the same kinds of difficulties in surveying in the Florida Keys that he will in Michigan, Wisconsin, Pennsylvania, or New York; but rest assured, he will find many more of them per mile. He will often encounter the problem of lost or obliterated corners, with all associated witness marks also gone. In trying to trace descriptions originally prepared by certain untrained persons, who consider themselves "land experts" because they enjoy prestige in other lines of endeavor, the surveyor will find that he is involved in the same kinds of snarls that he is on the mainland. Here he will find the *sand-lot* lawyer (I do not mean attorney), who *knows* more law than any really qualified lawyer does, and who will attempt to tell the surveyor where and how to run his lines. He will find land not occupied as described and land not described as occupied, and so on *ad infinitum,* just as will surveyors on the mainland.

The approach to the solution of these problems, however, is decidedly different on the Keys. Even where it is possible to reestablish the corners beyond dispute, we find that we must literally "tie our findings into the stars" in order to be able to recover them. This is because of the limited amount of *fast* land, the lack of stable referencing points, and the nature of the surface of the land here. Furthermore, the land in most places must be filled before it can be permanently occupied; therefore, ordinary monumentation is not usually recoverable after a short lapse of time. By literally "tying them into the stars," I mean using State plane coordinates based on Coast and Geodetic Survey monuments and tidal bench marks. The bench marks are important, as they are based on mean low water and on them is based the division line between *fast* lands and bay bottom lands, and deep water. With these facts in mind, I will try to describe to you some of the approaches to our problems and the solutions thereof.

To set the scene, I should like to quote the following from Chief Justice Cooley's *Judicial Functions of Surveyors:* ". . . When a man has had a training in one of the exact sciences, where every problem within its purview is supposed to be susceptible of accurate solution, he is likely to be not a little impatient when he is told that, under some circumstances, he must recognize inaccuracies, and govern his action by facts which lead him away from the results which theoretically he ought to reach. Observation warrants us in saying that this remark may frequently be made of surveyors."

Were Judge Cooley writing his treatise today, he might have added, "Having reached the results, based on the sifting of evidence, the surveyor should now describe and tie in his results, so that those following in his footsteps will not meet the same difficulties that he did." And by the way, if I were to give any one piece of valuable advice to a young engineer considering specializing in property surveying, it would be to study Cooley's *Judicial Functions of Surveyors* until he knew it by heart, because it contains the philosophy of the legal aspects of surveying, whereas Clark, Skelton, Hodgman, Patton, and others, cover the details. It is remarkable that Judge Cooley in 1869 could have laid down such excellent procedures for surveyors to follow and that so few surveyors (and lawyers) have followed them ever since. To revive Cooley in the thinking necessary to adequate surveying, I quote him freely herein.

When disputing parties call in a surveyor,

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it is his duty to find, if possible, the original marks or stakes, or the places where they were, which mark the boundary line between the pieces of property. These monuments must govern, however erroneous the original survey may have been, for purchasers buy, or are supposed to buy, with reference to these monuments, and they are entitled to what is within their lines and no more. It is remarkable how many surveyors wholly mistake their duty where the monuments are gone and all witnesses have been obliterated. It is a common mistake to assume that the only thing to be done is to place new monuments where the old ones should have been had they been placed correctly. This is a serious mistake.

The problem remains, as it originally was, to ascertain in the best manner possible where the original monuments were. All concerned will admit that no man loses title to his land merely because the evidence becomes lost or uncertain, although it may become difficult for him to establish his rights against an adverse claimant; but theoretically the right remains, and it remains as a potential fact so long as he can present better evidence than any other person. And it often happens that, notwithstanding the loss of all traces of a corner, there will still be evidence from which a competent surveyor can determine with almost absolute certainty where the original monuments were. There are two senses in which the term "lost and obliterated" may be used in this connection: first, the sense of physical disappearance; and second, the sense of loss of all reliable evidence. If the former sense is meant, it is plain that it would be a serious mistake to suppose that a surveyor could be clothed with authority to establish new corners by an arbitrary rule. It would be almost equivalent to saying that if a man loses his deed he has lost the ownership of his land. But, if by a "lost and obliterated corner" is meant one with respect to which all reliable location evidence is lost, there would undoubtedly be a presumption that the corner was correctly fixed by the original surveyor where the field notes indicated it should be. However, this is only a presumption, which may be overthrown by any satisfactory evidence showing that, in fact, the corner was placed elsewhere.

We are concerned with property rights. The original surveys must govern, and the laws under which they were made must govern, because the land was bought in reference to them. Any legislation, or act of an attorney, court, or surveyor that might have the effect of changing these would be inoperative insofar as the owner's vested rights are concerned. In any case of a disputed boundary line, unless the parties concerned settle the controversy by agreement, the determination of the line is necessarily a judicial act that must proceed upon evidence and give full opportunity for a hearing. No arbitrary rules of survey or of evidence can be laid down whereby it can be adjudged. The general duty of a surveyor in such cases is plain enough; he is not to assume that a monument is *lost* when it is merely obliterated. It is not *lost* until after he has thoroughly sifted the evidence and found himself absolutely unable to trace it. Even then he should hesitate a long while before doing anything to disturb settled possessions. Occupation, especially if long continued, often affords very satisfactory evidence of the original boundary when no other is attainable. There are cases where one or more corners are lost but all parties concerned have acquiesced in lines that were based on some other corner or landmark, which may or may not have been trustworthy; but to discredit these lines, when the people concerned do not question them, could lead to a legal controversy in which the law, as well as common sense, would declare that a supposed boundary line long acquiesced in, is better evidence of where the real line should be than any survey made after the original monuments have disappeared.

It is commonly but erroneously believed that lines do not become fixed by acquiescence in less than the statutory period. In fact, by statute, road lines may become conclusively fixed in less time than private lines. No specified period of time is re-

quired to determine the private ownership where it appears that the owners have accepted a specified line as their boundary. It should be borne in mind, however, that this refers to lines established by acquiescence, and that such acquiescence upon a common line cannot exist if either party insists upon possessing a specified area which, when bounded by such lines, adversely affects other opposite boundaries which will be in dispute with persons not party to such acquiescence. Therein lies a grave responsibility of the surveyor and the court if they accept a line agreed to by acquiescence without full knowledge of its ultimate effect on the property rights involved in adjoining lands. In other words, a minor local line controversy cannot be settled by acquiescence at the cost of future controversies affecting an entire area, by "ironing-out" the error to and beyond the horizon. This calls to mind the fact that *property* and *survey* lines are not necessarily the same, and the difference sometimes calls for new descriptions to facilitate future recovery.

From the foregoing it will appear that the duty of the surveyor, where boundaries are in dispute, must be governed by the circumstances. He has to search for original monuments, or for the places where they were originally located, and allow these to govern if he finds them, unless he has reason to believe that agreements of the parties, express or implied, have rendered them unimportant. In the case of government land surveys in the sectionalized part of the country, the term "monuments" means, of course, the corners and quarter-corner marks. Reference points, blazed lines, or marked trees on the lines are not monuments; they are merely guides to lead one with more or less accuracy to where the monuments may be found. If the original monuments are no longer recoverable, the question of location becomes merely one of evidence. It is idle for any surveyor to locate or "establish" a corner as the place of the original monument, according to some inflexible rule. On the contrary, he must inquire into all the facts, giving due prominence to the acts of parties concerned, and always keeping in mind, first, that neither his opinion nor his survey can be conclusive upon parties concerned; and, second, that courts and juries may be required to follow after the surveyor over the same ground, and that it is exceedingly desirable that he govern his action by the same lights and rules that will govern theirs.

A surveyor may advantageously act as mediator between parties, and help to prevent legal controversies by settling doubtful lines, but unless he has been legally appointed an arbitrator, the contending parties cannot be compelled to follow his judgment; however, if he brings about an agreement, and the parties carry it into effect by actually conforming their occupation to his lines, the action will conclude them. Of course, it is desirable that all such agreements be reduced to writing and made a matter of public record; but this is not absolutely indispensable if they are carried into effect without such record.

As can readily be seen, the rules that govern surveying on the mainland also govern surveying on the Keys, but the application of these rules is more difficult because there are townships where, of the perimeter of the township and of the perimeters of the 36 sections within that township, only ¼ to ½ mile of line will have been on *fast* land and actually surveyed. This condition varies in degree only from township to township. The conditions under which the original surveys were made and the nature of the surface of the Keys is such that most monuments were obliterated immediately after they were located. There was, and is, no such thing as vegetation growth of sufficient size and hardiness to be used as witness trees. Shorelines were consequently used as reference points and one merely has to compare the old and new maps of the Keys to see how inadequate such references can be. The controversy as to whether land that was once classed as bay bottom is now *fast* land, or vice versa, is inherent in each and every survey involving

shorelines. Although reference is made to government corners in most cases, the original location of such government corners is now a moot question. This places a tremendous responsibility on the property surveyor. Large tracts of land have been bought by absentee owners who rarely, if ever, saw the land they bought; the use of the waterfront has been their only interest so parole evidence is meager. Fences are rare as there is no livestock on the Keys. Furthermore, mangrove trees grow rankly in the shallow waters along the shores of the Keys and a mangrove jungle is all that the term implies; it is impenetrable. The most recent and best tied-in points in this area were the structures and mile posts of the Florida East Coast Railroad and Florida Highway 4–A, both of which have been abandoned and most of whose structures have been altered or removed entirely. Nothing is stable here; and descriptions made by landowners, real estate agents, and lawyers abound.

We decided very quickly that our duty to the client and a major contribution to the profession would be to describe and reference property corners as surveyed so that they could be recovered or replaced, regardless of destruction by hurricanes, floods, construction, or otherwise. The use of State plane coordinates based on the control stations of the Coast and Geodetic Survey network seemed the most feasible and expedient method, as it combined control, accessibility, and recoverability.

To expedite this work we wrote to our good friend, Ralph Berry of the Coast and Geodetic Survey, for copies of all available control data on the Keys and to the Bureau of Land Management for records of any recently reestablished section corners. The response was both quick and effective. Today we are keeping records in such a way that any competent surveyor with a knowledge of the use of plane coordinates is able to recover any land or property corners that we identify or reestablish.

As might be expected, we find it necessary to overcome the reluctance of abstracters, attorneys, and landowners to accept the new descriptions necessary to make recovery reliable and coincide with property rights. For instance, we find occupied land covering parts of two government lots, although the original description calls for it all to be in one government lot, all evidence pointing, however, to the fact that the occupied land was the land exchanged in the original transaction. We also find land as occupied lying completely outside the description boundaries of the original survey, due either to the occupant moving with the accretion and changes in shoreline, or to the fact that the tract occupied was erroneously left out of the original government survey but included in the property transaction. Here again we encounter survey lines versus property lines with improper conveyancing thrown in for good measure.

We are also faced with the problem of fostering a new brain-child. It comprises the extension of government land lines out into the bay bottoms, and lines bounding tracts which were not, and should not have been, included in the original government surveys. These tracts of bay bottom are usually, at the time of our survey, being transferred from the State of Florida to the purchaser. We have endeavored to continue the pattern of existing townships, ranges, and sections, and find ourselves faced with the difficult problem of attempting to match up new lines, created by accurate field work and mathematics, with the old lines on the *fast* land.

We are accepting the fact that minor coordinate adjustments will be necessary in the future in some of these cases because of the prohibitive cost of planning and proving a large network, as clients are not willing to pay for work beyond the needs of their particular problem, nor should they be required to. This should not affect property boundaries, however, as relationships, once established, remain stable.

I believe I have described above in some detail the conditions with which a surveyor must be familiar before attempting to practice property surveying on the Florida Keys.

I will now describe in detail the solution of one specific problem that we encountered. The description read something like this:

All that portion of Government Lot 1, Section *S*, Township *X*, Range *Y*, lying north of a line that is 200 feet north of the centerline of Florida Highway 4–A.

When we arrived at the site we could see nothing but water, dotted with a few small islands. Investigation developed these facts: the Bureau of Land Management had recently reestablished the northeast corner of Section 25 in this township (please note that it is on the Range line), and had moved it about 300 feet north and about 200 feet east of where it was thought to have been when the highway and the railroad were constructed, thus affecting a whole township. Our section was 2 miles west and 1 mile south of this; but the nearest Coast and Geodetic Survey monument was 5 miles west and 1 mile south. Practically all the government lot involved was dredged to obtain fill material to construct the railroad, Florida Highway 4–A, and the new U. S. Highway 1, so that there were no old shorelines against which to check the original survey. Highway 4–A has since been abandoned in part. There was controversy as to whether the centerline of U. S. Highway 1 was super-imposed over the centerline of the old Florida East Coast Railroad, as it was reputed to be. The changing of the section corner on the Range line moved our section line out into deeper water. This lengthened the necessary causeway to connect the main key with one of the pertinent islands, which involved our client in much greater construction costs than he had anticipated when he considered this project. Note that even though a government lot was in question, the section line over water was considered because of pertinent bay bottom rights that were involved.

Our first task was to prove the original section line and show how, when shifting along the shoreline from convex to concave outlines, the changes in direction of the extension lines normal to the shoreline (necessary for delineation of bay bottom) would affect the areas of this bay bottom our client would be entitled to purchase. This determination was very important as it could either include or exclude valuable islands and channels. The abutting property owners watched carefully and jealously guarded their rights in these matters. Our last problem was to prove where Highway 4–A had been originally.

Our survey would have been useless unless we could carry into court irrefutable evidence in our client's favor. Furthermore our survey would still be useless if it were not recoverable at will. We proceeded as follows: inasmuch as temporary recoverability during survey was as difficult to maintain as would be future permanent recoverability, we immediately decided to use a control network that included three Coast and Geodetic Survey control stations and the existing Highway 1 as our working base. In running the highway survey we tied in all P.I.'s, P.C.'s, and P.T.'s, section and quarter-section corners, subdivision monuments, lot survey stakes, structures, and so forth, plotted them on a large-scale map, and calculated the State plane coordinates of every point we had included in our survey. Some of these points were identical with points determined by the Coast and Geodetic Survey, and our values have proved to be identical, to two decimal places, with the C. and G. S. values; and our azimuths and back azimuths are identical with theirs.

This procedure gave us a working grid on which we could start any survey in the area after running a line of not over 1,000 feet, and a base for our plane coordinates. The next step was to superimpose the Bureau of Land Management (formerly General Land Office) townships, range, and section grid over this, using the recently reestablished northeast corner of Section 25 as the pivot point and the farthest west acknowledged section corner within our grid, as a tie-in, to orient the two grids. We then gave each of these section and quarter-section corners their local plane coordinate values. Then we superimposed boundaries as described and recorded, and

gave these corners their local plane coordinate values, thereby expressing all data in terms of the control grid. We found in some instances that land as occupied checked very closely with the original survey, but in other instances it varied as much as 300 feet and 4° or 5° in bearing. But, at least we had a picture of conditions as they actually existed.

Basing all our decisions on the philosophy as expressed by Chief Justice Cooley, and as detailed by Clarke, Skelton, Hodgman, Patton, *et al*, we have obtained some answers that establish our client's claim to various lands and islands in a manner that will be difficult to refute. We have repeated the process from time to time along the Keys, and inasmuch as our plane coordinates are actually C. and G. S. State plane coordinates, it is becoming less difficult to locate ourselves accurately in places as yet unsurveyed by us through the use of the three-point method and intersection of lines, the values being computed as coordinates. The use of such methods along the Keys in time will eliminate controversies and litigation, which in itself will prove the value of such painstaking methods. The ever-increasing value of the land involved justifies the expenditures commensurate with this work.

In conclusion, I believe that sufficient data have been presented to lead one interested in this exhaustive subject along the proper path. I believe we have also proved one other vital point and that is, though adequate surveying is expensive, it does not cost too much where the results obtained are so beneficial to a client, or to a community.

WATTS MICROPTIC ALIDADE

Places

Speed and Accuracy on your Plane Table

I.

Three scales in view

Vertical Angle in degrees and minutes

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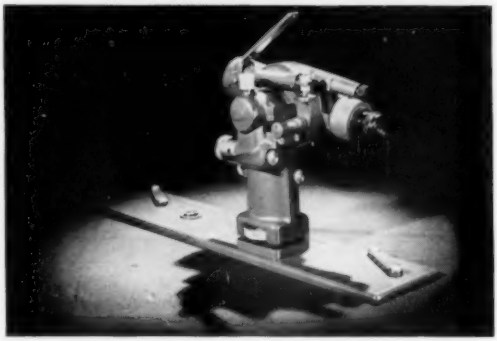
Correction factor for true horizontal distance

II.

Parallel rule on blade



III.

Behind the instrument reading

Internal glass scales

No verniers to read

IV.

Clean and rugged design

Catalogues on Theodolites, Levels, Magnetometers available upon request.

JARRELL-ASH COMPANY 26 Farwell Street Newtonville 60, Mass.

West Coast Representative: A. Lietz Co., San Francisco, Calif.

The Chorographic Compage[1] Map

By JOHN FRASER HART and EUGENE MATHER

DEPARTMENT OF GEOGRAPHY AND GEOLOGY, THE UNIVERSITY OF GEORGIA

GEOGRAPHERS frequently require a cartographic technique which will depict a variety of geographic information on a single map in such a manner that areal relationships are quickly and readily apparent. Although the amount of information

[1] The term, "compage," was proposed by the Committee on Regional Geography of the Centennial Studies Committee of the Association of American Geographers in a preliminary report presented by the Chairman of that Committee, Derwent Whittlesey, to the 46th Annual Meeting of the Association in Worcester, Mass., during April 1950. The Committee suggested that this term be used to refer to "units differentiated with respect to the entire content of earth-space," implying an association of place and people as "wholes." The compage map presents a variety of related data for numerous specific selected locations within an area. The selected locations are indicated on the small central map, with the data presented in boxes ranged around its borders.

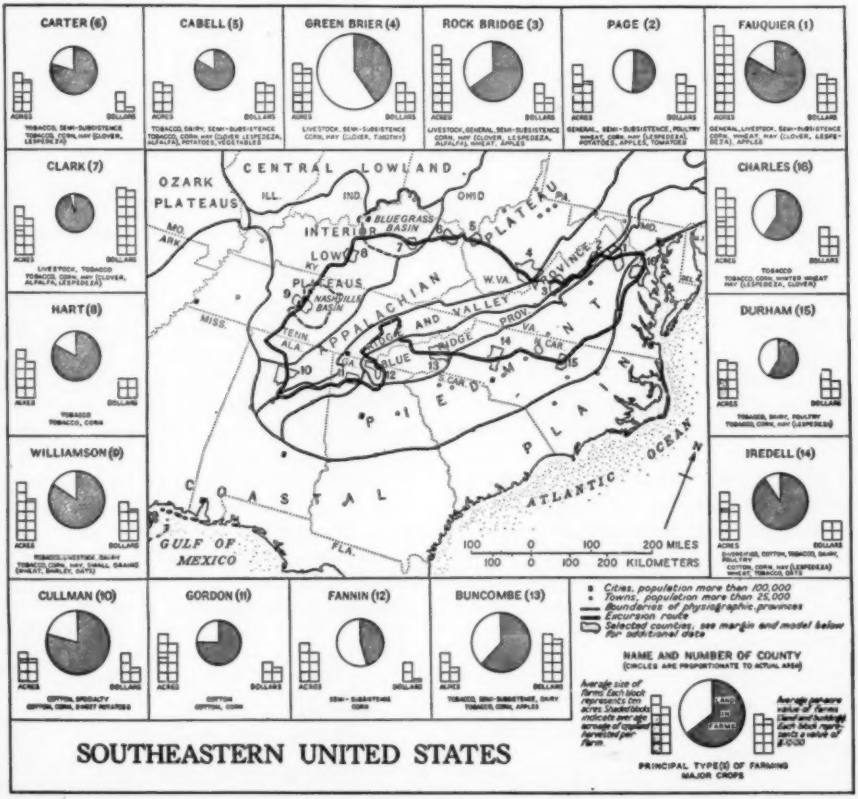


FIGURE 1.—Chorographic compage map of Southeastern United States showing principal types of farming.

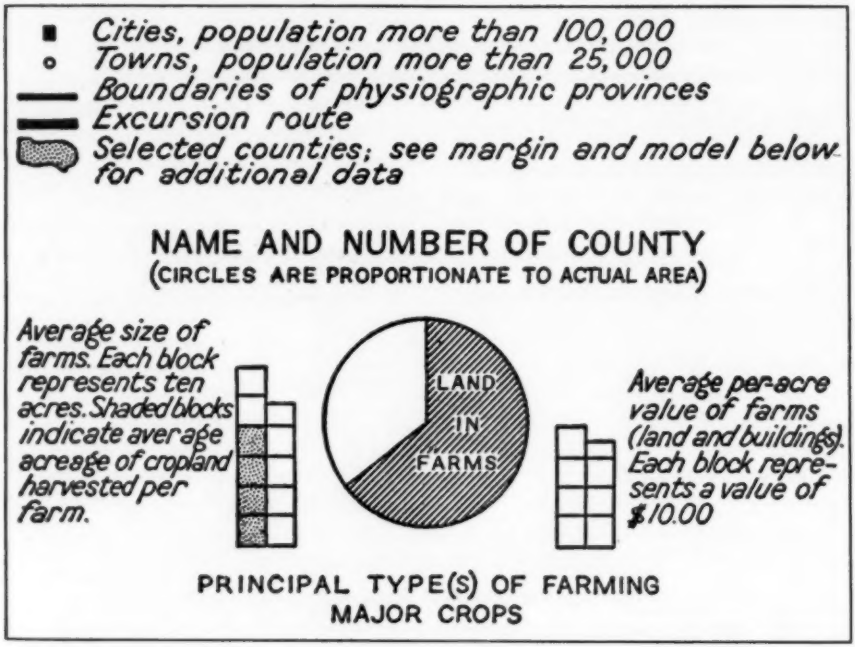

Cities, population more than 100,000
Towns, population more than 25,000
Boundaries of physiographic provinces
Excursion route
Selected counties; see margin and model below for additional data
NAME AND NUMBER OF COUNTY
(CIRCLES ARE PROPORTIONATE TO ACTUAL AREA)
Average size of farms. Each block represents ten acres. Shaded blocks indicate average acreage of cropland harvested per farm.
LAND IN FARMS
Average per-acre value of farms (land and buildings). Each block represents a value of $10.00
PRINCIPAL TYPE(S) OF FARMING
MAJOR CROPS

FIGURE 2.—Legend for chorographic compage map.

tion that can be conveyed by any one map is obviously limited, the advantages of a single map, particularly for work in the field, are self-evident. Considerable mechanical skill is involved in manipulating a number of maps; in the wind it is virtually impossible to compare them; even under ideal conditions, relationships are more readily apparent from the study of a single map than of a series, and field observation is thereby facilitated. Such an individual map can be especially useful when it contains an areal synthesis of statistical data. Thus it obviates the carrying of voluminous material into the field and simultaneously permits field mapping and notation on the same sheet containing the data.

A chorographic compage map of Southeastern United States (Fig. 1)[2] was prepared for field and reference use in conjunction with the International Geographical Union tour of the Southeast.[3] The paucity of adequate maps of the Southeast, especially those of a statistical nature, posed a problem. It was necessary to give foreign geographers an accurate, objective impression of the areas through which they were traveling. On the other hand, a series of maps prepared on the basis of single criteria might have been more confusing than helpful to individuals who were relatively unfamiliar with the area, as it frequently proves difficult to make a mental transfer of information from one map to another. It is more useful to portray desired data for selected representative areas only, es-

[2] This map was compiled and designed by the authors and was drafted by E. D. Weldon of the American Geographical Society, New York.

[3] Eugene Mather and John Fraser Hart, *Southeastern Excursion Guidebook, XVIIth International Geographical Congress* (Washington: International Geographical Union, 1952), map following page 135.

pecially if such data can be shown on a single map to which reference can readily be made in the field.

The chorographic compage map was an experimental technique of cartographic presentation which proved its worth when used in the field by sixty foreign geographers. It was used enroute and at each of the field stops. Constant reference was made to the map to compare statistical data with the actual landscape. Many members of the group commented that comprehensive data for the entire Southeast, or maps based on such data, would have been overwhelming, whereas data for selected counties were readily comprehended when viewed in their areal relationships. The only real criticism was the obvious impossibility of cramming more county diagrams onto the single map. The enthusiasm with which the chorographic compage technique was received seems to commend it to serious consideration by professional geographers.

The legend for the map (Fig. 2) is the model upon which each individual county graph is based. The area of the circle is proportionate to the actual area of the county; the shaded portion of the circle represents the percentage of that county in farms. The simple bar graph on the right portrays the average per acre value of farms, including land and buildings. The com-

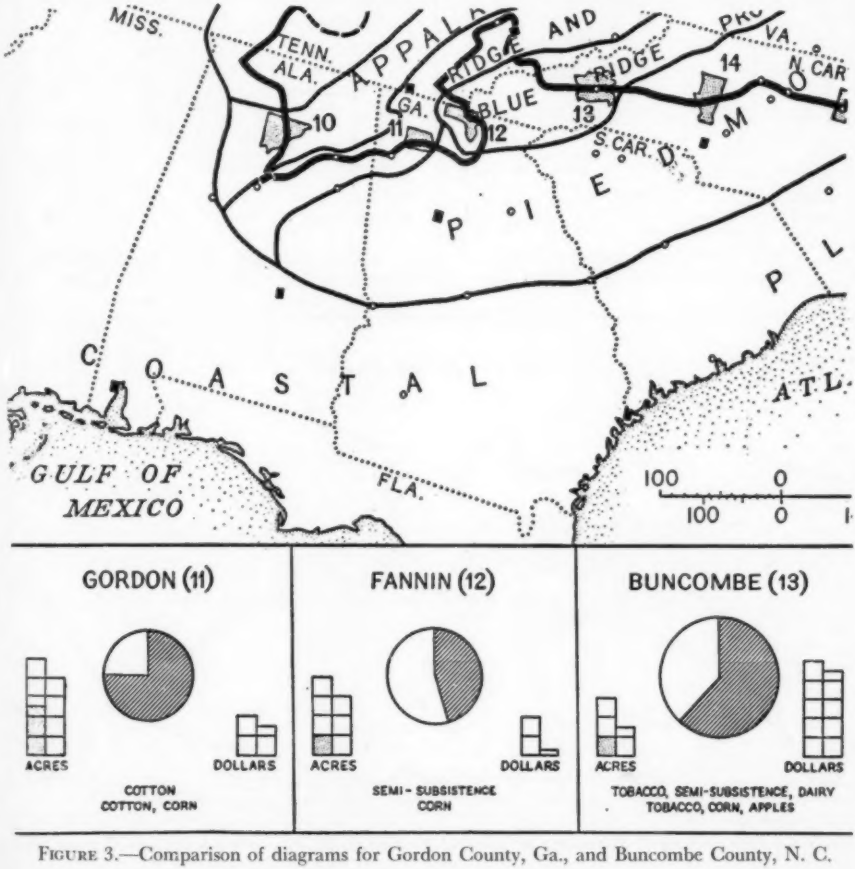


FIGURE 3.—Comparison of diagrams for Gordon County, Ga., and Buncombe County, N. C.

pound bar graph on the left depicts the average size of farm; the average acreage of cropland harvested per farm is indicated by the shaded portion of the graph. The principal type of farming and the major crops, as indicated by the 1945 Census, are shown at the base of each county diagram.[4]

[4] Although these data proved most pertinent in a single specific instance, it is obvious that a wide variety of data might have been used equally well.

A comparison of the diagrams for Gordon County, Ga., and Buncombe County, N. C. (Fig. 3), reveals the amount of information which may be obtained from these graphs. Note the sharp contrasts between, *first,* the amount of land in farms; *second,* the total size of individual farms; *third,* the acreages of cropland harvested per farm; *fourth,* the per acre value of farms; and *fifth,* the farm economics of the Asheville Basin, as presented by Buncombe County, and the Blue

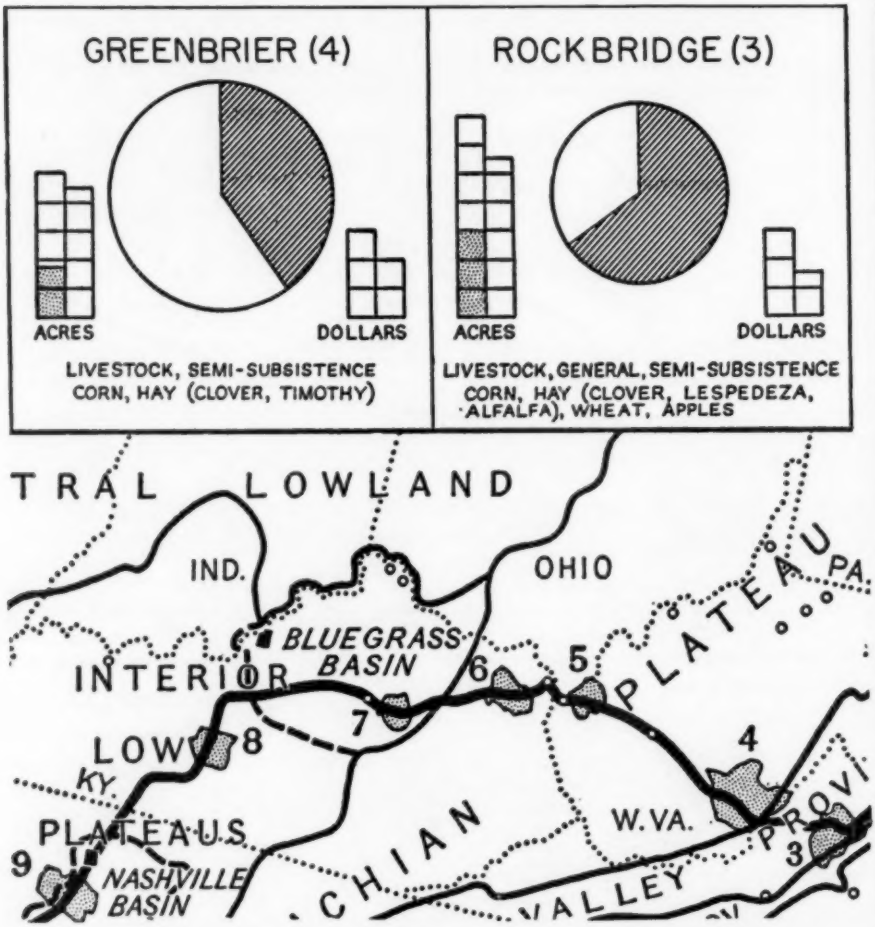


FIGURE 4.—Comparison of diagrams for Greenbrier County, W. Va., and Rockbridge County, Va.

Ridge of North Georgia, as shown by Gordon County.

Further comparison between any two other county diagrams will also reveal striking differences, as indicated by the contrast between Greenbrier County, W. Va., in the Appalachian Plateau, and Rockbridge County, Va., in the Ridge and Valley Province (Fig. 4).

This technique of the chorographic compage map might be employed for the cartographic presentation of statistical data for various types of rural landscapes, urban landscapes, extractive industries, or for other comparisons where statistical data are applicable in an areal relationship. The chorographic compage map is particularly valuable for instructional purposes, especially when students are being trained in techniques of field observation. Many other applications of this technique will be apparent to students in related fields.

Covered Glass Reticles on Surveying Instruments

Covered glass reticles, which permit cleaning of surveying instrument reticles without danger of destroying the fine lines, are now a feature of transits and levels offered by W. & L. E. Gurley, Troy, N. Y.

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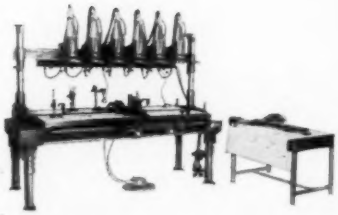

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Polaris

(The aurora displays which I remember vividly were in 1918, when we were fighting the Communists in Northern Russia, in the Archangel district. I had command of a small allied force called the Left Bank Dwina River Column, with American, British, Australian, and Canadian troops, and a smattering also of White Russians, French, and other nationalities, a kind of miniature United Nations.—Pat Boyd)

To get True North, surveyors "shoot" Polaris,
And best at one particular time of night;
Two weeks or more I nightly searched the Heavens,
But only clouds would meet my eager sight.

But late last night the skies were clear as crystal,
The stars stood out like points of tiny spears;
"Aha," said I, "No camouflage this evening,
A watch I'll keep when elongation nears."

A hasty glance at half-past three this morning,
Polaris still was circling 'round the Pole;
By four o'clock the instrument was ready,
A short half-hour, and then the long-sought goal.

What shimmers on the Northern far horizon,
Like clouds that run before a rushing gale?
But faintly luminous, and softly glowing,
A skyward surge of pastel colors pale.

Spray from some stormy sea of magic radiance
That men have called "Aurora Borealis,"
Dashing around that beacon of the North,
Wayfarer's guiding star, the pale Polaris.

A score of years and more have marched their way
Since in Archangel's drear November snow,
We watched in awe an Arctic Borealis,
On perilous patrol, or sentry-go.

No pallid copy like tonight's performance,
But clouds and streamers half across the sky,
Weaving and blending in a vast crescendo,
A glorious blaze; and then the flame would die

Away—and faint as old loves long forgotten,
A vague, mysterious light would dimly glow;
Then once again, from nadir to the zenith,
Up flamed the glory, 'gainst dark pines and snow.

No human hand could pen that wondrous beauty,
No artist brush conceive those colors rare,
No Taj Mahal embrace one tenth the splendor
That God has lavished on the Arctic air.

Four-thirty now, and time I should be doing,
No rhapsodies, or dreams of army days;
What's this? the sky is overcast; the clouds
Have veiled Polaris, and there are no ways

To pierce the fleecy mask that hides the Heavens,
My bed of comfort I have left in vain;
"Meridian" must wait; an aggravation,
Until a clearer night shall come again.

How like the life of ordinary mortal,
To plan, and wait, perhaps to sacrifice
For some inviting goal, or fancied pleasure,
And then have Someone say to you, "No Dice."

—R. P. Boyd
Eau Claire, Wisc.

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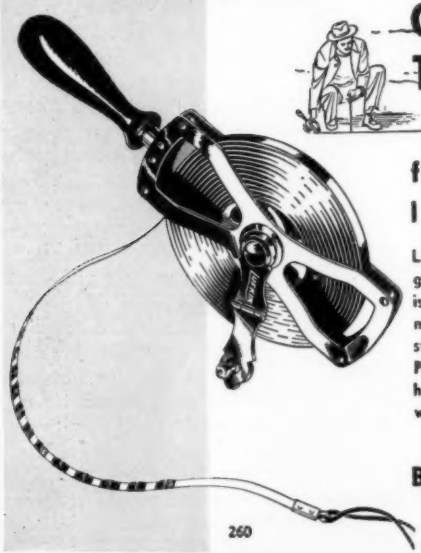

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Should Underground Utilities Be Referenced to the State Coordinate System?

By THOMAS W. SHIVES

ANNE ARUNDEL COUNTY SANITARY COMMISSION, MARYLAND

VARIOUS local coordinate systems have been in use for many years in different areas of Maryland so the first point to consider in connection with the title of this paper seems to be the idea of selling to the various engineering groups the advantages of converting to the established State system. Not until then can the full benefits of coordinating underground structures be attained. As the cost of conversion may be almost prohibitive in areas such as the city of Baltimore where there are thousands of coordinate stations and hundreds of maps based on local coordinates, it will take some super-salesmanship to persuade the city to make this change. Many agencies and towns, however, do not use any kind of coordinate system nor keep adequate maps of their underground installations and most of their work is done in a rather haphazard way. These groups would also have to be sold on the idea if the full benefits of coordinating records are to be realized.

My 12-year-old son, when listening to a discussion concerning the wedding of a close female relative, overheard someone say that it was the intention to fill the refrigerator and kitchen cabinets with necessary foodstuffs so that when the honeymooners returned they would be in a position to start housekeeping without purchasing any food. He remarked, "It seems kind of silly to buy all that stuff when she doesn't even know how to cook." Similarly, many people might say there is no need to set up a coordinate system, much less a plan for coordinating underground structures, as long as we have no one, in many sections of the State, who is able to do the required coordinate cooking.

Presented at the Thirteenth Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., March 23–25, 1953.

It is my opinion that all utilities should make their records uniform by adopting State coordinates as rapidly as possible. This is advantageous even if it requires that dual records be kept during the conversion period by the groups now basing their work on some local origin.

Much of the value of locating underground structures by coordinates is lost unless equally accurate control is also available. Such vertical control should be based on a single datum. In the Baltimore area there are at least seven different level datums used by various agencies. As we have adequate horizontal and vertical control in our area, we are very favorably situated. Our underground structures have been coordinated for the past thirty years and although not all lines are directly coordinated, all sewer and water mains are tied in to the control points so that position values can easily be determined.

One advantage that has been most apparent to us is the ability to pin-point valves or manholes and re-establish their location after all reference points such as curbs, poles, and buildings have been lost because of major surface improvement programs such as road modifications. Even minor rearrangements of surface structures and road resurfacing make it difficult to relocate underground lines unless they can be sighted in from nearby control points.

When various agencies are working in the same area, problems can develop in arranging to clear the lines of another utility unless all groups have tied in their structures to the same reference points. If, for instance, the gas company in Baltimore would give us the coordinate values of tees, valves, and so forth, on their gas mains, or direct measurements from control points, we could accurately locate the utilities on our plats and give the gas company exact information as

to the clearance between their structures and ours. Their present method of furnishing location plats with proposed gas mains tied in to pole lines or hedge or fence lines creates conflicting locations when, several years later, others try to use these dimensions after the pole lines or other physical reference points have been relocated.

UNDERGROUND INVENTORY

It becomes more necessary each year to have definite information concerning underground structures as more lines are put beneath the surface. With low- and high-pressure water lines, storm and sanitary sewers, steam lines, gas lines, and electric and telephone ducts interlaced horizontally and vertically in narrow streets and with replacement and repairs necessary on many of these lines, it is imperative that various utilities be coordinated. To coordinate the installation of their structures in the generally accepted meaning of the word, the various utilities should use the State Coordinate System and the mean sea level datum.

When a utility is working in several sections of a large area where it is anticipated that the future may require that the several sections be connected by the services provided by the utility, there are many advantages to having the underground structures coordinated. By converting the geographic positions established by the U. S. Coast and Geodetic Survey to State coordinates, the underground utilities can be properly correlated. In this connection, vertical control is also important in planning for future installations. Coordinates facilitate computations so that the proper pipe size can be predetermined without the need of extensive surveys between the areas served. Hydraulic problems are simplified by having the coordinate values as well as the elevations of various points when new construction is contemplated.

In summary, I believe we should strive for the best inventorying of all public service underground structures by encouraging engineering agencies and public utility firms to use the State Plane Coordinate System. The extension and use of a good quality vertical control system based on a common datum such as mean sea level is also very much needed.

* * *

A Challenge to Title Men

OCCASIONALLY in this business one chances to come across deeds which were recorded many years ago which would try the patience of not only the Saints but any enterprising title man. The following is one which was recently found to be of record in a northern California county and is actually a legal document, according to the best of our knowledge.

Know all men by these presents that we, Palmer and Baldwin of Dotans Bar and I. C. Hawthorne of Auburn, Calif., in consideration of the sum of one dime to us in hand paid by John Burckman of Ophir, the receipt whereof is hereby acknowledged do hereby release, quit claim, and convey unto said John Burckman, his heirs and aforesigned forever all that certain lot in the former village of Ophir, once occupied by a restaurant by Jacob Herchemer and Mary, his wife. Said lot being on the lower side of the only street in the place which was once Ophir and is now Ophirville, and situated between the buildings once owned by Porter & Story as a butcher-shop and a building supposed to be used once for unknown purposes, now no building at all, but a very good place for one, aforesaid building or place for building, being or having been next adjoining a building called the "El Dorado," which said "El Dorado" has been removed or is being removed or will be removed or should have been removed long ago to Auburn—before the fire. The dimensions of said lot being easily ascertainable by reference to the memory of the oldest inhabitant and being of no particular matter anyhow, being the same more or less.

Filed 18th of June, 1855, at 10 o'clock a.m., Placer County Recorders Office.

Reprinted from *American Right of Way Association News.*

Use of Modern Instruments in Surveying Instruction

By MARVIN C. MAY

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NEW MEXICO

SURVEYING is probably the oldest and most universally taught course in the civil engineering curriculum. Its great age, however, has not resulted in senility. On the contrary, surveying as now practiced is a rapidly expanding art, readily adapting itself to modern conditions and demands. The value of good surveying in engineering practice is generally recognized, and greater emphasis is being placed on work of high accuracy.

Unfortunately, surveying instruction is usually regarded with apathy by the instructors involved and with condescension by the other staff members. In many schools the task of teaching surveying is handed to the lowest ranking instructor, the new man who is in no position to complain, and who usually regards it as a disagreeable task which he must do until he has an opportunity to teach other subjects in which he had had advanced training and in which he is more interested. It seems that the same school that will go to considerable trouble and expense to secure just the right man it wants to teach structures or soil mechanics, will assume that *anyone can teach surveying* and will not even insist on practical experience in the field.

One reason for the apathy with which surveying instruction is usually regarded is that the surveying curriculum in most schools has been relatively static for many years. The techniques and instruments used are those of 50 years ago, which is in marked contrast with the developments in the teaching of structures, sanitary engineering, and other civil engineering subjects. Fortunately, there are available the means to invigorate and revitalize surveying instruction. One way is to place more emphasis on photogrammetry. Although complete courses in photogrammetry probably should be taught at the graduate level, nevertheless, students taking the regular surveying courses could at least be introduced to the advantages and techniques of photogrammetry. Greater emphasis can be placed on the more precise types of surveying, such as second-order triangulation and leveling. Radar and shoran, as used in surveying, should be discussed, as they are opening up entirely new fields. However desirable the above recommendations are, they are not adaptable to the basic *on-the-ground* instruction program. Here the best means of improving instruction is through the use of modern instruments.

Let us see what we mean by modern instruments. By *modern* we certainly do not mean 1951 models of an 1880 design. Unfortunately, the standard American transit has changed but little in the last 50 years. The most recent models, when compared with instruments made in the last century, show only minor modifications in dimensions and such superficial improvements as coated optics. The standard level looks as if it had been designed to sell by the yard or the pound. There are available, however, surveying instruments that have been designed along modern lines. Those instruments have been developed mainly in Switzerland, but are now being manufactured in Germany, England, Italy, and Japan as well. They embody most of the following features, which are essential if an instrument is to be classed as truly modern:

(1) *Accuracy.*—The day of the 1-minute transit has passed and modern instruments reflect this fact by making it possible to read angles with an accuracy of 10 seconds or less

Presented at the annual meeting of The American Society for Engineering Education at Michigan State College, Lansing Mich., on June 28, 1951.

without repetition.

(2) *Light weight.*—All the modern optical-reading instruments are much lighter, usually about 50 percent, than the conventional instrument of comparable accuracy. Light weight means less fatigue on the part of the operator and makes it easy to move the instrument more quickly from point to point.

(3) *Speed of operation.*—Modern instruments permit a speed of operation which cannot be equaled by conventional instruments. All angles, both horizontal and vertical, are read by means of microscopes that are usually placed immediately adjacent to the telescope eyepiece. Level bubbles are also visible from the eyepiece end of the telescope and it is unnecessary for the operator to move his position while operating the instrument.

(4) *Ruggedness.*—Modern instruments are rugged. All critical parts are completely enclosed and are far less susceptible to damage due to dust or moisture than conventional instruments.

(5) *Optical plummet.*—The optical plummet is a feature of most modern instruments. It permits the operator to position his instrument over a point more quickly and more accurately than he can by using a plumb bob. The fact that the optical plummet is not affected by wind is a great advantage.

(6) *Rifle sights.*—Modern instruments are equipped with rifle-type open sights which permit the operator to find a distant target quickly without having to search for it through the relatively small field of view of the telescope. This improvement, costing only a few cents, can save the operator several minutes in the course of each day's work.

(7) *Coincident level bubbles.*—Modern levels, and some of the transits, are equipped with coincident bubbles and embody the tilting principle, features which make the operation of the instrument faster and more accurate.

(8) *Self-reducing stadia.*—Modern alidades, and some of the transits, have self-reducing stadia diaphrams which automatically correct the stadia reading for the inclination of the line of sight.

(9) *Packaging.*—Modern instruments deserve modern packaging and most of them have it in the form of an all-metal, airtight, watertight, and dustproof container that protects the instrument from shock and damage due to moisture and dust.

At the University of New Mexico our Wilds and Kerns are not pampered pets. They are not *display* instruments, but are used in every operation we perform. In the time that we have had them they have been used more hours by the students than our other instruments and they are apparently less likely to be damaged in the hands of the students than conventional equipment. The fact that they can be carried into the field in their protective steel cases is of considerable value to us; it lessens the danger of damage in transit. As all critical parts, such as the circles and bearings, are completely enclosed, we have not found it necessary as yet to clean or lubricate these instruments. By contrast, our conventional instruments must be cleaned and relubricated about once a year in this very dry dusty climate.

The use of these instruments in surveying instruction permits the introduction of special techniques, and challenges the instructor and students to develop new ones. The Wild T-2 is ideally designed for teaching astronomical work and the measurement of triangulation angles. The Wild T-1 is probably the best all-round instructional instrument, as it has the double centers of the conventional transit and can be used for all operations normally performed with the transit. We use them in advanced surveying and in curves and earthworks. By the use of a diagonal eyepiece attachment, solar and Polaris observations are made accurately and simply. The vertical-circle level permits obtaining very accurate vertical angles, especially when direct and reverse readings are made on all three horizontal crosshairs. By this procedure we have been able to determine latitude by observations on Polaris at culmination that check the Coast and Geodetic Survey within a few seconds of arc.

By using a T-1 together with a pentagonal prism and two range rods we have a method of *superstadia* that permits us, in our very open country, to make mile-long jumps across canyons and arroyos with an indicated error of not over 5 feet per mile. In this procedure we send two rodmen forward a mile or so, where, by using the

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pentagonal prism and a 100-foot tape, they set two range rods exactly 100 feet apart and at right angles to the line back to the instrument. The instrument man then reads the small angle subtended by the rods, repeating it four times on four different parts of the circle. This can be done in less than 4 minutes and the cotangent of the mean angle is taken from the appropriate table. By moving the decimal point over two places, one has the horizontal distance free from slope error and the differential refraction error that plagues long stadia shots. We believe this method might be very useful for reconnaissance surveys in the Western States where the open country and clear atmosphere will permit such long shots.

The NK-3 Kern level, which we use as a replacement for the conventional dumpy level, has the unique feature of bringing the image of the coincidence bubble inside the telescope tube and placing it alongside the crosshairs. Our students find they can operate it more accurately and much faster than regular levels.

Student reaction to these modern instruments is invariably favorable. They find that they can learn to level the three-screw leveling bases faster than they can the four-screw type. The optical micrometers on the theodolites are mastered in less time than it takes to learn how to read a vernier. They like the light weight, the compact appearance, the accuracy they obtain, and, above all, the feeling that they are using equipment designed along modern lines and not the brass-bound relics of their grandfathers. As a consequence, they take greater pride in their work and more interest in the course.

The value of such training might be questioned in that it might seem that we are training our students to use equipment which they will not see after they graduate. We do not believe this to be true, for a number of our graduates have told us that they are using optical theodolites in their work for government and private organizations. In the Western States we know, for instance, that such equipment is being used by the Bureau of Reclamation, the Geological Survey, the Forest Service, the U. S. Engineers, and by a number of private organizations. Even if such instruments were not in common use we would still feel justified in instructing the student in their use because a university should teach the techniques and practices of tomorrow and not of yesterday.

There have been some complaints, as shown by articles and letters in SURVEYING AND MAPPING, about the slowness of American instrument makers in developing modern instruments. But the instrument makers say that they cannot afford to tool up to produce such instruments until they have a reasonably assured market. This market will not develop until a large number of engineers are acquainted with the advantages of the newer instruments. Here the schools can perform a service by introducing their students to these instruments and in time the desired market will develop.

New Projection Drawing Machine

A new aerial view projection drawing machine has recently been developed.

This machine is designed to convert regular engineering or architectural drawings into three-dimensional illustrations which are mechanically accurate and scalable. These drawings have no vanishing point, no converging lines, and no central point of view. They may be made as isometric, dimetric, or trimetric projections.

The machine may be used to convert regular contour or topographic maps into three-dimensional maps.

Additional information concerning this instrument may be obtained from the manufacturer.[1]

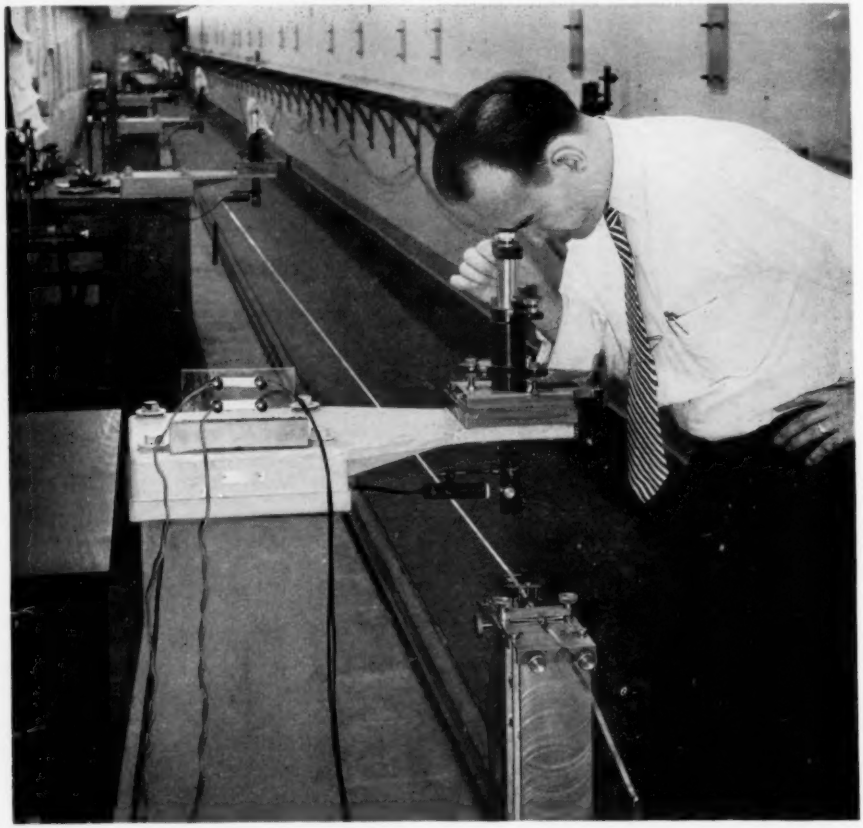
[1] Air-Vu Co, 1244 Broadway, Denver 3, Colo.

Thermal Expansion of Invar Surveying Tapes

A NEW METHOD for determining the coefficients of linear thermal expansion of invar[1] geodetic surveying tapes has been developed by Peter Hidnert and R. K. Kirby of the National Bureau of Standards. Based on a determined relationship between the electrical resistance and the temperature for each invar tape, the NBS technique consists principally of measurements of expansion and electrical resistance of the tape when heated by passing a direct current through it without changing the temperature of the laboratory. The new method is not only more precise but also much more rapid and convenient than the previous method, which required measurements at different ambient temperatures.

For accurate determinations of long distances

[1] Invar is a nickel steel containing about 36 percent nickel. Its coefficient of linear expansion is very small at ordinary temperatures.



Observation being made at a terminal graduation of a geodetic surveying tape in the National Bureau of Standards tape testing laboratory. In the new NBS method for determining coefficients of thermal expansion of invar tapes, each tape is heated by passing a direct current through it while the ambient temperature of the laboratory is held constant. The resulting change in length or linear expansion is observed directly by means of two microscopes focused on the terminal graduations of the tape.

with geodetic tapes, as in measurements of base lines by the U. S. Coast and Geodetic Survey, the coefficient of thermal expansion of each tape is needed in order to calculate the lengths at various atmospheric temperatures. Over the past half century, NBS has determined the coefficients of expansion of many invar tapes for government agencies. The measurements are carried out in a specially designed underground laboratory. Until now, the length of each tape was measured at several different constant temperatures from 5° C. to 35° C. by comparison with a distance laid off with a 5-meter steel standard maintained at 0° C. by packing it in melting ice. To obtain the various constant temperatures, it was necessary to change the temperature of the entire laboratory. Several days were allowed for the equipment to reach equilibrium conditions at each temperature. Furthermore, additional time and effort were spent in making the large number of precise measurements of length and temperature that were required.

In the new NBS method, the temperature of the laboratory is held constant at a convenient temperature. The tape, under a specified tension, is supported in the same manner as used in the field, but it is electrically insulated from the supporting apparatus. Micrometer microscopes are focused on the terminal graduations of the tape, and the change in length or linear expansion is observed directly when the tape is heated by passing a direct current through it. The electrical resistance corresponding to each observation for linear expansion is determined by a potentiometer method. Measurements of the lengths of the tape by means of the 5-meter steel standard are no longer needed for expansion determinations. The temperature coefficient of resistance of the tape is used to convert the observed changes in resistance to temperature changes. Then, from the length of the tape, the observed changes in length, and the corresponding temperature changes, the coefficient of linear thermal expansion is calculated. The temperatures at which the observations apply are obtained by adding the determined temperature changes to the initial temperature of the tape as determined by thermometers hung in close proximity to the tape.

The temperature coefficient of resistance of each tape can either be obtained experimentally or computed from an empirical relationship derived at NBS between the temperature coefficient of resistance and the mass resistivity of invar tapes. The mass resistivity is easily determined by multiplying the resistance per unit length by the mass per unit length.

Coefficients of expansion of five 50-meter invar tapes obtained by the new method have been found to be in good agreement with those obtained from the same tapes by the old method. The probable errors of the coefficients of expansion determined by the new method are approximately 0.01×10^{-6} per degree centigrade and are less than the probable errors of the coefficients of the same tapes by the former method.

Course in Geodetic Measurements

An international course in measurement of distances is being held in Munich from September 14 to 30, 1953, under the sponsorship of the Geodätisches Institut der Technischen Hochschule München in cooperation with the Institut für Angewandte Geodäsie at Frankfurt am Main and the Deutches Geodätisches Forschungsinstitut. The course is planned as a continuation of the series formerly arranged by Otto Von Gruber and sponsored by the Carl Zeiss Company.

The program comprises lectures, discussions, and practical demonstrations of all direct and indirect procedures of distance measurement as well as the theory and application of modern methods of base measurement. New equipment demonstrated includes the Zeiss-Opton Level Ni 2, Breithaupt-Heckmann Precise Level, Breithaupt-Berroth Transit, Askania-Gigas Theodolite with radio-operated photographic registration of the horizontal and vertical circle, Wild T-3 Theodolite with radio-operated photographic registration, Kern DKM 3 Theodolite, Askania Gravitymeter Gs 9, Askania Microbarometer, Avanzini Computing Machine, Ramsayer Function Calculator and the Rellensman Azimuth Gyroscope.

Visits are planned to engineering schools in the area and to the firms of Karl Wenschow GmbH in Munich; Klimsch & Co., makers of reproduction equipment, Frankfurt am Main; Zeiss-Opton, Oberkochen; and to the Zeiss-Aerotopograph exhibition rooms in Munich.

Interesting side trips are planned to the Bavarian Alps and to nearby lakes, castles, and other points of interest.

Avoiding Wasteful Boundary Litigation

By WILLIAM H. MOSS, L. S.

TITLE ENGINEER, THE DISTRICT TITLE INSURANCE CO., WASHINGTON, D. C.

THE CAUSES of boundary disputes in regard to property lines are extremely numerous, as any surveyor who has had a fair amount of experience in field survey work can readily testify.

Since the very beginning of our record system, the attempt has been made to describe, by means of written deeds and descriptions, certain areas, tracts, or parcels of land by giving to as many lines as possible a descriptive numerical value (bearing and distance) and by relating the ends of these lines to physical markers on the ground such as trees, stones, and iron pipes. We must admit that this system, if carried out in an accurate and reliable manner, would be completely satisfactory.

However, due to the inaccuracy of old-time instruments (for measuring both angles and distances) and due also, I fear, to the lack of knowledge of some of our predecessors and to the lack of durability of some of the physical markers chosen, we find on occasion that it is practically impossible to re-establish a given line in true relation to its original position. Therefore, we assume from the beginning that the causes of boundary disputes arise from the fact that there is a lack of physical evidence on the ground which definitely establishes the true location of the boundary line in question.

It is not at all unusual to find instances where an individual property owner has, in the absence of definite markers, established his own property line by means of physical barriers such as fences, farm roads, and tree plantings, this establishment being based on his "recollection," his "know how," or his "that's it and I defy anybody to move it" attitude. In many cases these improvements go uncontested for several years until it is brought to light when the adjoining property owner has a survey made which shows the encroachment and gives rise to a boundary dispute.

Other cases of boundary disputes may occur within recorded subdivisions. They may be caused by inaccuracies in the computation of the original plat, or by inaccurate work by the surveyor in staking out one of the lots. These errors may not come to light until several subsequent surveys have been made, some of which may be based on the original inaccuracies. In such instances, it is quite possible to have a "chain reaction" or series of overlaps, and, hence, a series of boundary disputes.

In trying to establish the main causes of boundary disputes, we come to the conclusion that the majority of these disputes are the result of a lack of physical, permanent markers, or a lack of a basic knowledge of the importance of having them replaced or set if missing.

Most boundary disputes are settled by a competent survey or by arbitration; however, there are far too many that reach a stage of litigation. The reasons for this, of course, are various and run all the way from just plain "stubbornness" to the actual necessity of having a court rule on the validity of the claims.

Later on in this paper we will try to establish some preventive measures, but for the present we must assume that the reason boundary disputes reach litigation is the lack of complete understanding of all the factors contributing to the cause of the dispute.

In any court trial involving a boundary dispute, the cost is almost always large. When we take into consideration the cost of filing, attorneys' fees, lost time of all parties concerned including witnesses, court fees, and so on, we have a basic cost that will run well into three figures. Now the regrettable part of this is that 90 percent of litigated boundary disputes involve parcels

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of land that in their entirety are worth less than half the cost of the trial. So the resultant waste is not only measured in time, effort, and strained tempers, but in money as well.

In regard to preventive measures, we must agree that the most important item in settling a boundary dispute is a competent and exhaustive survey showing all of the contributing factors that have resulted in the dispute. In most cases, this information, when properly presented to the parties concerned, results in an immediate settlement based on the claims of one or the other, or is instrumental in the establishment of a line arbitrated by the surveyor.

At this point, it is pertinent to call attention to a paper which was read at the 1952 annual meeting of the ACSM (and subsequently published in the October–December 1952 issue of SURVEYING AND MAPPING) by D. I. O'Gallagher, President of the Corporation of Quebec Land Surveyors, in which he discusses at length a process of dispute settlement known in Canada as the "Procès-Verbal." This process is the most important link uniting the practical and judicial expressions of their laws of real property. In this paper, Mr. O'Gallagher states: "Whether the case be amicable or judicial, the surveyor must be prepared to weigh conflicting evidence, face possible hostility, read deeds, and study plans. He must meet the parties in the case, their representatives, witnesses, and lawyers, and often a gallery of curious onlookers at a free and sometimes very dramatic show. Assuming that all formalities in a dispute have been complied with, the actual survey and plan finished, and the boundary marks set and recorded, our surveyor must then complete his operation by drawing up his Procès-Verbal. The tension does not cease until he has secured the signatures of both parties on this document." (The document referred to is apparently a part of the plat and constitutes an acknowledgment by both parties of their acceptance. The legality of such a document is verified by the ensuing court judgment.) "Once the Procès-Verbal has been signed by the parties, it constitutes a definite title between them as to the contents and limits assigned to each."

May we assume that the answer to our problems of dispute might be some process similar to the Procès-Verbal, in which certain qualified and designated surveyors act as both surveyor and arbitration judge?

Until such time as we can adopt a similar process, our answer, of course, is to redouble our efforts in trying to attain a greater degree of accuracy both in our computations and our setting of permanent field markers.

"Introduction to Texas Land Surveying"

A new soft-cover booklet on land surveying practices in Texas, compiled by M. E. Spry, Registered Professional Engineer and Licensed Land Surveyor of Odessa, Tex., has recently been published.[1]

The booklet, entitled "Introduction to Texas Land Surveying," is an informative reference containing valuable data on Texas land surveying. The material is not new but has been gathered from many sources. Its content is indicated by the chapter headings: Texas Land Transactions; Field Notes; Surveyors (general requirements, county surveyors, licensed State surveyors); Surveying Practice; and Boundary Law.

The material related to the surveying of land boundaries is arranged in the order generally encountered when actually making a survey of the boundaries of a tract of land. The disposition of the public domain, how land survey records should be made and are maintained, the perpetuation of land boundary lines, some of the laws regulating transactions, and the surveyor's responsibility in these matters are all explained.

[1] The *Gage Printing Co.*, 1810 Kermit Highway, Odessa, Tex.

Contribution of Control to Economic Development

(*A Panel Discussion*)

The four articles which follow were presented as a panel discussion at the technical session of the Control Surveys Division at the Thirteenth Annual Meeting of the American Congress on Surveying and Mapping at Washington, D. C., on March 25, 1953. Four aspects of the subject are presented by the articles—the contribution of control to economic development in the petroleum industry, in urban planning, in conservation, and in national defense.

Following the four papers is presented part of the discussion from the floor.

—EDITOR

PANEL ON "CONTRIBUTION OF CONTROL TO ECONOMIC DEVELOPMENT"

Left to right: G. W. Herzog; Bernard H. Kock; B. Everett Beavin, Sr., Moderator; Marshall S. Wright; and Floyd W. Hough.

Contribution of Control to Economic Development in the Petroleum Industry

By G. W. HERZOG

SHELL OIL COMPANY

THE NEED for utilizing horizontal control in Texas or any other State continues to grow, and everyone associated with land survey work is daily more conscious of this fact. Every lost or obliterated corner is mute evidence of the necessity for using and tying to control systems. The passing on of old settlers, whose knowledge of corner locations is invaluable, adds to the confusion. Ever-changing rivers and waterways which form boundaries further amplify the need for using coordinate systems. We, in the petroleum industry, are fully conscious of the value of control and we will be among those in the forefront to utilize State coordinates in our land surveys. One need only look into the history of Texas to realize the complex problems associated with retracement surveys.

TEXAS SURVEYS

The history of Texas is largely based upon the history of its lands. Spain opened its door to colonization of the vast wilderness of what is now Texas in 1821 when it made a grant to Moses Austin to settle three hundred families. After Mexico had overthrown the Spanish government, she continued the latter's policy of granting lands to Americans. Upon our separation from Mexico, we respected the valid titles to land which had been extended by Spain and Mexico; but all the vacant land within our borders became the property of Texas and

subject to her control. Texas continued to grant land to colonists until her admission into the Union on July 4, 1845. Since that time, she has encouraged colonization through headright and bounties, grants for colonies, pre-emption homestead donations, donations to veterans, and the sale of land to pay public debts and for internal improvements. She has made large grants to railroads to induce them to locate lines within her borders. Since most of these grants were made with colonization in mind, many of the surveys are multi-sided and conform to no standard pattern. Many are bounded by streams and were originally surveyed so that each land owner would have frontage on these streams. The earlier grants were frequently widely scattered. Later, the remaining portions of the land were granted, filling in the gaps between groups of surveys. Thus Texas is made up of many thousands of surveys, each independently recognized by the State Land Office, and described by metes and bounds. Each tract is subject only to its original calls and those of adjoining surveys for its location.

All deeds down to the present date are derived from the original surveys, and all distances are measured and described by varas (33⅓ inches), a measure used by the Spanish and Mexicans. Our land laws and courts recognize as valid the old Spanish and Mexican surveys as well as deeds prepared from them as our legal descriptions. A total reform in thinking must come about (in land laws) before land descriptions can legally be tied to recognized control points. This reform must also affect all individuals involved in land surveying practice.

With this introduction, the reader may conclude that control surveys are not used by us in surveying lands in Texas. This is not altogether true. The petroleum industry is using established control in off-shore location work and in much of its mapping. However, due to the lack of adequate control inland, we seldom have an opportunity to tie to established control on inland retracement surveys. In the first place, it would be too costly to run many miles of line to tie in recovered property corners. Each day we spend to re-establish an original corner is lost to any future program for use of coordinates because we can seldom afford to return after making a retracement survey except to make well locations.

In summarizing the matter as it applies to Texas, consideration must be given to the complexities prevalent in such a land setup as regards the described lands and the laws governing such descriptions. The USC&GS and State network systems are inadequate as to coverage of the State, thus making it out of the question for us to tie to these networks on many survey jobs located inland from the Texas coastline. Other than the improvement of our professional status through going that second mile, as explained by Sol Bauer,[1] we gain nothing for this extra expenditure of time and labor.

Despite all this, we not only have use for control—we lean on it heavily in two branches of our work. One of the most important is that of mapping off-shore waterways.

MAPPING

In the petroleum industry, we have had many rude awakenings to the need for accurately controlled maps in our search for oil and gas. We can look back and see that considerable progress has been made toward our goal of good maps; however, much remains to be done not only for our industry but for industry in general. The coverage of this country by truly good maps is still inadequate. Although our government is making great strides to alleviate this condition, all of us who work with maps should exert more effort to emphasize this need for more and better controlled maps.

We, in Texas, are primarily concerned with two particular types of maps, both of which require a high order of control. One is the land ownership map. The other type of map is used in the subdivision of the submerged land areas. These particular maps are used by all in the petroleum industry, but mainly by the exploration departments

[1] *See* "The Value of Control Surveys to the Property Surveyor," SURVEYING AND MAPPING, October–December 1952, pp. 338 to 342.

to record geophysical and geological data. As an illustration of our need for accurately controlled maps, I will point out some of the problems in connection with our mapping program which embraces all submerged areas off the shores of Texas. These submerged areas cover all water bottoms to which the State of Texas claims title, such as those beneath rivers, bays, and all offshore waters.

Shortly before World War II, the State authorized its Land Commissioner to subdivide these submerged lands and submit them to the public for the sale of oil and gas leases. Accordingly, the Commissioner had subdivisions prepared of a number of rivers as well as the Gulf of Mexico. Twice each year, certain tracts of these subdivisions are advertised for lease and sealed bids are accepted by the State.

The first of these subdivisions was controlled by a base line usually running on a cardinal course through some U. S. Coast and Geodetic Survey triangulation station. This method of control for the subdivisions created many problems in calculation and surveying. The Commissioner has now referenced the subdivisions to the State Plane Coordinate System. That is to say, the maps are now constructed on the Lambert Conformal Conic projection.

A question which might arise at this point is what was behind the development of the Plane Coordinate System especially when we already have a perfect expression of control in the national network of triangulation. While it is true that all surveys could be expressed in geodetic coordinates, it is not a very widely accepted practice because of the long and tedious calculations involved. This fact was largely responsible for the development of the Plane Coordinate System. The value of plane coordinates cannot be over-emphasized especially in connection with our operations in the submerged land area. In most cases, we are dealing with an area located several miles from shore in a bay or the Gulf of Mexico.

Quite naturally, our appreciation of plane coordinates lies in the simplicity of constructing a good map. Maps are a vital part of our search for new oil fields from the time we begin to work up a prospect until the first drill site is staked on the ground. The geophysicist must have a good map upon which to plot the results of his findings in the field. The geologist must have an equally good map to make his interpretations and select a drill site and, finally, the surveyor must stake the location for the site exactly as the geologist designates. It is obvious that these combined efforts are lost if the maps with which these men work are not accurately controlled, and more especially so if all their maps are not constructed from the same base. Regardless of how accurate the original data of the exploration department may be, the value of its conclusions depends entirely upon the accuracy of the map. It is entirely possible for a mapping error of a few feet to result in a dry hole with subsequent abandonment of an entire oil field.

STATE PLANE COORDINATES

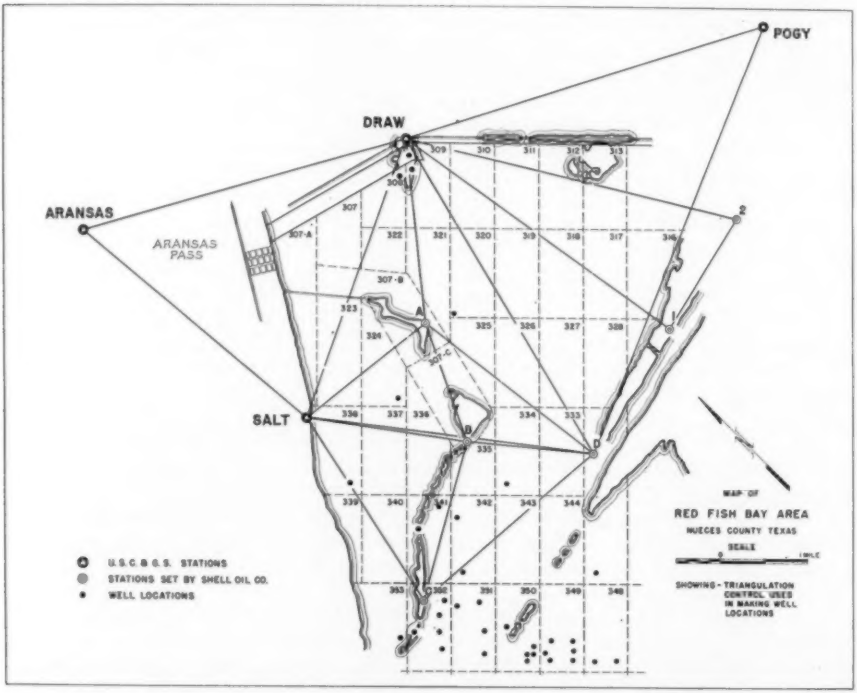
The most notable contribution of control surveys to economic development in the petroleum industry is found along the coastal bays of Texas. The minerals underlying the beds of these coastal bays are owned in trust by the State of Texas. It might be added that the citizens of Texas through their legislature have wisely committed all revenue derived from the submerged land from lease bonus and royalty payments to the education of its youth, through the public school fund.

Experience has proven that coast and harbor charts accurately define the Texas coastline and its adjacent bays. Using these charts as a base, a larger map is compiled to a more suitable scale which reflects the outline of the bay. All triangulation stations falling within the limits of the map are then plotted. The correct relationship between the control points and the topographic features of the area are reflected on the newly constructed map. One of the triangulation stations most accessible to the bay area is selected from which to control the construction of the subdivision. A base

or construction line is run through the selected station in such a direction that a practical pattern of subdivided tracts will result. The boundary lines of all tracts are then made either parallel or at right angles to the grid bearings of the selected base line. The only exception to this rule is where the shoreline of an island or the mainland forms one of the boundary lines. The size of the regular tracts varies as between bays. The tracts in the smaller bays generally embrace 160 acres. The tracts in the larger bays and the Gulf itself contain up to 640 acres. The Land Commissioner varies the size of the tracts so that the State will get the maximum benefit from the competitive bidding.

In Texas, just as it had done in other States, the Coast and Geodetic Survey has converted the geodetic coordinates of its control stations to State plane coordinate values. The Lambert System was employed, using five zones. The Lambert coordinate values for the "key" control station, through which the subdivision base line passes, is used to compute coordinate values for all subdivision corners. Complicated geodetic computations are thus eliminated. The position of any point or line in the bay can be determined with the usual methods of plane trigonometry and plane analytic geometry. Therefore, it can be readily seen that the advantages of using the national geodetic triangulation net still permits the retention of the simplicity of plane surveying procedures.

With this data and the procedures just outlined, the Land Commissioner prepares a very accurate map from which planning, exploration, and development can be carried on by the oil companies. The availability of Coast and Geodetic Survey data without a doubt benefits not only the State of Texas, but also private industry. From related experiences with government agencies, a practical conjecture would indicate that the burden of supplying necessary sur-



vey data to the Land Commissioner would fall on the oil companies if it were not already available. In other words, the Land Commissioner would probably require the company or companies interested in bidding to supply him with adequate survey data from which to prepare a map. The time and expense involved would materially retard economic development of the submerged lands. It is estimated that an expenditure involving $18,000 and requiring four months time would be necessary for an oil company to survey the physical features, establish horizontal control, and map an average bay along the coast. After the job was completed, it would still lack the advantages afforded by a tie to the national network and the State Plane Coordinate System.

Only after the completion of the subdivision map, and not until then, is the submerged land ready to be advertised for mineral development. Intense interest is exhibited by the oil companies when the Land Commissioner advertises tracts in any area for lease. Sealed bids only are accepted. Each tract is bid on separately rather than groups of tracts. These bids may range from a few hundred dollars to $50,000 and more per tract. The legal description in the lease instrument of the tract awarded to each high bidder is by reference to what is now called the official map which was prepared from USC&GS data.

With well founded confidence in these controlled maps, oil companies undertake to develop their respective leases. Portions of many of the leased State tracts have drilling restrictions. These restrictions are imposed by the Corps of Engineers at the request of local navigation districts and branches of the armed services. It is imperative that an oil company never locate a drilling rig in a restricted area. The surveyor is primarily responsible for complying with these regulations. Well locations are staked from the monuments established by the Coast and Geodetic Survey as a part of their national net or from control points tied in to this net by other agencies, most notably the U. S. Corps of Engineers. State plane coordinate values can be readily obtained by visiting the U. S. Engineer's field office nearest the area of interest.

Having a controlled map and several coordinated control points at his disposal, the staking operations conducted by the surveyor are comparatively simple. Two sets of coordinate values of the proposed location are first computed by making independent calculations from two control points. The two sets of values must agree before they are accepted. A mathematical check is also made of all determined grid bearings and angles. A traverse is set up which includes the proposed well site and all control stations to be occupied.

The first phase of the drilling operation consists of driving piling for the drilling barge. Two 20-second transits are set up on predetermined control stations and accurately oriented. The 60-foot boom of the pile-driving barge is then "talked" into position by the instrument men with the aid of portable pack phones. After the barge has been placed on location, a third station is occupied to check the accuracy of the field work and preclude the possibility of an error.

The tremendous cost and risk involved in drilling a well on a submerged tract demands absolute accuracy in locating well sites. Exploratory wells drilled to a comparatively shallow depth of 8,000 to 8,500 feet cost as high as $300,000 to $400,000. If and when production is found, the routine development of the field drops to an approximate cost of $125,000 per well, which is still a high figure.

In summary, we can again emphasize the contribution of control surveys to economic development in the petroleum industry concerning the search for oil in the coastal waterways. As previously pointed out, the initial or exploratory well usually costs not less than $300,000 to drill. On an estimated cost of $18,000 to accurately survey the shore line and island, set control stations, and map a bay according to present standards, this would represent six percent of the total drilling costs. With the aid of the Coast and Geodetic Survey data, the pre-

sent cost of staking the initial well can usually be held to approximately one-fourth of one percent.

In conclusion, it can be readily seen that USC&GS control surveys make a very tangible and important contribution to the national economy and defense by greatly reducing the cost of searching for oil.

Contribution of Control to Urban Planning

By BERNARD H. KOCK

PRINCIPAL ENGINEER, CITY ENGINEERING DIVISION,
CITY OF CINCINNATI, OHIO

MUNICIPAL control surveys, normally an integral part of any topographic or other map program, are seldom considered as independently useful operations and their value, therefore, is generally unappreciated by municipal officials and regrettably even by engineers and surveyors. However, four separate surveys carried out by Cincinnati during its history have clearly demonstrated their worth.

The first recorded control, covering 16 sections and completed in 1873, is still a basis for testimony in litigation involving location and elevation of streets and properties. The monetary value of the savings realized from this survey would be difficult to determine but could be conservatively estimated to be $250,000, or 100 times its original cost. The 200 monuments comprising control used for the city topographic map of 1912 have saved a minimum of $10,000 in annual field survey costs alone, excluding the indirect savings to planners, contractors, subdividers, and others. In 1933 an enlarged street-improvement program required the expansion of this vertical control to 400 bench marks. During the interval prior to 1948 when the present county-wide metropolitan topographic survey was initiated, the 1933 control system has been indispensable and has certainly repaid its cost many times to the taxpayers. The joint city-county mapping and control program, now in progress, will eventually cover 440 square miles of county area. Despite the fact that the program is incomplete, its value is far in excess of its cost to date. It has been determined, as a matter of fact, that the costs incurred have already been recovered on the following projects:

(1) The Blue Ash Master Airport Improvement including approach zones and access roads.
(2) Mill Creek Channel line control.
(3) The Metropolitan Freeway Program.
(4) Municipal water distribution system records.
(5) Underground and sewer records.
(6) Proposed trunkline sewer projects.
(7) Flood control and riverfront development.

Considering vertical control only, the actual money savings to the taxpayer can best be illustrated by a comparison of the annual costs of two systems, one based on a minimum concentration of one monument per 5-mile interval, the other, on Cincinnati's concentration of one pair of monuments per 1-mile interval. The system of using assumed level datums will be ignored, since it is the most costly and unreliable, not only for survey purposes but also in planning, design, and integration of future construction. A number of very expensive errors have resulted from the use of assumed datums. This has been costly to individual property owners as well as the general public.

These comparative costs are illustrated below, utilizing certain basic information assembled from Cincinnati Engineering Division records as follows:

Benchmark usage by 15 Cincinnati engineering crews	25 per year
Crew cost, including transportation	$8.00 per hour
Leveling speed	4 miles per day
Leveling cost	$16.00 per mile

PLAN A

(Five-mile interval concentration with temporary intermediate benchmarks)

Average leveling distance ..... 7.5 miles
Cost of establishing temporary benchmark = (7.5) × ($16) $120
Annual cost based on Cincinnati's usage = ($120) × (15) × (25) $45,000

PLAN B

(Cincinnati concentration—pair of benchmarks at 1-mile intervals)

Cost of executing 1 mile of levels..... $16
Annual cost = ($16) × (15) × (25) $6,000

From the above it can be seen that the net savings, Plan B over Plan A, is $39,000 per year.

Although the savings from a similar horizontal control system of greater density could be similarly computed, our personnel are still in the initial stages of using this system and, while it has been adopted for water works and underground records as well as for all major planning, the annual savings, compared to the cost of uncoordinated surveys, could not be reliably set forth without considerable further experience.

The obvious conclusions from the experiences in Cincinnati are, therefore, as follows:

(1) No large village or city can economically afford to be without some form of horizontal and vertical control. The higher the concentration of monuments, the less expensive the cost of future surveys.

(2) The cost of any control will be more than repaid within several years after its establishment.

(3) Horizontal and vertical control offer tremendous advantages in industrial and residential development.

Contribution of Control to Conservation

By MARSHALL S. WRIGHT

U. S. DEPARTMENT OF AGRICULTURE

SO MUCH has been said, or will be said, by my colleagues on this panel on the important subject of control, that what I may be able to add is only epilogue.

The subject matter of control is in itself enormous and the field is varied. The word covers many activities. We not only have geodetic control, both horizontal and vertical, but we also have fire control, flood control, price control, mosquito control, and many other kinds of control. The word "control" is used in spiritualism, I understand, to describe the utterances of a medium. The poor word is so bedraggled and so worn and threadbare that I often wonder what an etymologist would think if he realized what had been done to what was originally a nice little transitive verb. There is no dearth of words in the English language and it would seem that a more descriptive word could have been found for the scientific processes used in determining and fixing positions on the earth's surface. Be that as it may, probably nothing can now be done about it. Accepted nomenclature cannot easily be changed as the mind no longer considers the familiar word itself, but only the meaning it conveys. I am bringing this matter to your attention, not to be facetious, but to emphasize that, now when we are about to step across the threshold into a new era where electronics and other scientific methods will replace many of our conventional processes, we give careful consideration and thought to the adoption and acceptance of new words and scientific terms. We might well emulate the chemist and even coin new words from a combination of initials to express complicated methods, procedures, or standards. I feel that our group, probably more than any other, will be affected by these new scientific processes, and consequently it must lead the way to a better and a more comprehensive understanding of the sciences involved. I am appreciative of the fact that some action along these lines has been taken, i.e., the adoption of initials in the formation of some new words, such as Loran and Shoran.

Now to the gist of my particular partici-

pation in this panel discussion, i.e., the contribution of control surveys to conservation. Conservation, in this particular instance, means the proper utilization, protection, and preservation of our natural resources. These resources are, in broad terms, the soil, the water, the minerals, the fuels, and our wildlife. Much has been written and more can be written on the conservation of all our resources, but time will not permit me to discuss the subject here in all its detail and correlated ramifications.

CONTROL SURVEYS

The magnificent work done by the U. S. Coast and Geodetic Survey and the U. S. Geological Survey is so well known to this group that there is no need for me to elaborate upon it. When the objectives established by the U. S. Coast and Geodetic Survey are reached and we have one triangulation station in each 7½-minute quadrangle, traverse stations located at 4-mile intervals on all main transportation routes, with closer spacing in metropolitan areas, plus areal leveling on lines spaced no more than 6 miles apart, the millennium will have arrived.

The development of vast areas, taking into account all sociologic and economic factors, must be predicated upon accurate and reliable basic information. Many people with various qualifications are required to intelligently conduct such a study; but basically underlying all the work that is done and the conclusions that are reached must be accurate and reliable information on the size, shape, and configuration of the area. This is the major contribution performed by the people that extend the vertical and horizontal control nets. Local and intensive detailed surveys must be based on one common datum. This is particularly true in large areas comparable to the Missouri River Basin and the Columbia River Basin where extensive flood control and irrigation projects are planned. Obviously, dam site locations must be accurately defined. The extent and rate of runoff is dependent upon the size, the configuration, and the shape of the land. These facts can be ascertained only when accurate horizontal and vertical locations are available.

The means of access to areas, the extent, direction, and degree of slope of the terrain all play a major part in the cutting of timber on our vast forested areas. Accurate topographic maps are essential in planning all extensive lumbering operations. Logging techniques are based on the utilization of gravity in felling and moving big trees to the sawmills.

When Man endeavors to plan large projects, extensive control surveys are necessary. These, in turn, must be plotted in miniature on conventional projections and scales, so as to permit a comprehensive graphic presentation. The process constitutes what, in my mind, is analogous to the assemblage of a vast three-dimensional jigsaw puzzle. Every part must fit together perfectly, both horizontally and vertically. It is in obtaining this relationship that the geodetic engineer and his methods of precision play the biggest part.

In the short time allotted to each participant of this panel it is impossible to do more than highlight or mention the necessity of and the benefits derived from the extension of an accurate network of geodetic position, but I hope the proposed forthcoming discussions will develop many interesting sidelights.

Contribution of Control to National Defense

By FLOYD W. HOUGH

CHIEF, GEODETIC DIVISION, ARMY MAP SERVICE

THE WORD "control" as used here refers to those surveys which determine the position of points on the earth's surface, both horizontally with respect to some selected origin and vertically above some selected level surface.

It is difficult to conceive of any type of economic development in which control surveys do not play some part. Highways, railroads, dams, tunnels, flood control, irrigation systems, parks, playgrounds, harbors, mines, oil fields, sewer systems, real estate subdivisions, airports, and building construction all require location or construction surveys involving horizontal or vertical control and usually both. Topographic mapping, which usually precedes an economic development, is entirely dependent upon horizontal and vertical control surveys if the correct relationship as to distance, direction, and elevation is to be maintained among the numerous features of the resulting map. Without this relationship within prescribed accuracy tolerances, no representation of a portion of the earth's surface on a plane can rightly be dignified by calling it a map, whether made by transit and chain surveys, by planetable, or by photogrammetric methods.

Basic control surveys of first- and second-order accuracy are properly termed "geodetic engineering" since they normally extend over a sufficiently great area of the earth's surface to require the application of the principles of geodesy. A geodetic first-order control system, both horizontal and vertical, should precede the economic development of a country in the same way that the foundation of a building is the first step in its construction. Unfortunately, such is generally not the case, with the result that the geodetic engineer is called upon to establish the foundation after the economic structure is well under way. This is wasteful in time and money because of the corrections which inevitably have to be applied to the results of the original survey. The lack of adequate control surveys in an economic development was painfully apparent following the tragic failure of the St. Francis Dam in California in March 1928. The City of Los Angeles was faced with lawsuits running into millions of dollars due to the loss of some 500 lives and extensive property damage. The city had considerable justification for its contention that the failure of the dam resulted from earth movement, or an Act of God. After a thorough examination of the original survey records, the writer felt compelled to testify in court that the original control survey at the time the dam was constructed was of third-order accuracy and that its positional error was approximately equal to the amount of earth movement which the city believed had taken place. It is entirely possible that an adequate geodetic survey, executed before the dam was built, would have enabled the city to prove its case for earth movement.

There is ample evidence that the necessity for geodetic control surveys is becoming clear to authorities and engineers responsible for economic development in the United States. The demand for engineers with good geodetic training and experience has grown rapidly since 1945 and far exceeds the supply. Our good friend, Prof. George H. Harding, Past President of the Congress, performed a notable task in establishing at Ohio State University in 1950 the first graduate program in the United States leading to Master of Science and Doctor of Philosophy degrees in geodesy. The scientific director of this educational program is the noted Prof. W. A. Heiskanen.

We must conclude that control surveys of some type are essential to any economic development. It seems to be only in the interpretation of the adequacy of these surveys that opinions differ among engineers responsible for such economic developments. Much too often in the past the authorities have taken the viewpoint that control surveys are a troublesome requirement preceding construction. They have begrudged the spending of a fraction of one percent of the total cost of a construction project for an adequate control survey. Many such surveys over large areas of previously unsurveyed country are paid for with taxpayers' funds and are not properly monumented simply because the control survey is considered only in the light of its value to that particular project. The result is that, in a few years, much of the control must be executed again, once more at the taxpayers' expense, in order to meet the requirements

of some newer economic development in the same area. Objectively speaking, this is short-sightedness, for the original control survey, adequately done and permanently monumented for a relatively few extra dollars, would have served engineering needs for many years to come.

It is hoped that the responsible authorities will recognize the engineering economy accruing to the taxpayer in the United States in allotting sufficient funds, even in lean years, to insure that basic permanent control surveys are established well in advance of topographic mapping and economic development.

Whenever control surveys are established, permanently marked, and tied in to the Federal network, particularly in an area previously uncontrolled, a contribution has been made to national defense. Such contribution may be made by Federal, State, municipal, or private organizations. The effectiveness and economy of artillery and anti-aircraft fire are greatly enhanced by adequate control based on a common datum and on a rectangular grid, because the distance and direction between the gun and the target can be quickly determined.

The military defensive potentiality of a country is thus related in no small way to the existence of accessible control survey stations. These should be in sufficient density to permit the rapid and accurate ranging and orientation of certain defensive equipment. Property owners in the United States should be encouraged to recognize their obligations to the Nation by preserving these survey monuments once they have been established.

It is obvious that the establishment and monumentation of control surveys are an asset to a nation not only because of their contribution to economic development but for their value in national defense.

DISCUSSION

MR. SIMMONS (U. S. Coast and Geodetic Survey): I would like to ask Mr. Kock a question. I presume your surveys are almost completed on the Ohio Coordinate System?

MR. KOCK: Yes, Mr. Simmons, all on the Ohio Coordinated System, south zone.

MR. SIMMONS: Have you ever found any actual use was made of them by property surveyors?

MR. KOCK: They are starting to use them, but it is going to take a little training. We are trying our best. We are in very close contact with all private surveyors. They are cooperating because it means a saving of money to use our maps. Many are using them, but it is going to take five more years, I would say, to bring the old-time surveyors into the picture so they will also use them. Our highway section, which receives subdivisions in their initial stages for approval, insists that they be tied in to the coordinate system, and that will perhaps encourage the surveyors to be a little more accurate.

CAPTAIN HEMPLE (U. S. Coast and Geodetic Survey, retired): My question is addressed to Mr. Herzog. As I understood your paper, Mr. Herzog, you do not use Federal control in the interior of Texas, but you do use it along the coast?

MR. HERZOG: That is right.

CAPTAIN HEMPLE: If the control were in the interior, would you use it?

MR. HERZOG: Not on mere land retracement survey.

CAPTAIN HEMPLE: Do you on monument surveys?

MR. HERZOG: We do.

CAPTAIN HEMPLE: If we put control there, wouldn't it be to your advantage to make a connection from your surveys to the control?

MR. HERZOG: Yes, it certainly would. Our trouble is that inland Texas has very little control. It costs us a great deal, even with all the money the oil companies have, to run a great distance merely to tie to a control system.

CAPTAIN HEMPLE: What is your definition of a great distance?

MR. HERZOG: Fifteen, twenty, or thirty miles.

CAPTAIN HEMPLE: With the program we are following, say around Houston where we have control at 6-mile intervals, would you use that?

MR. HERZOG: We surely would, and we tie to it constantly. We feel blessed that we have that particular control along the coast, especially from Corpus Christi through Houston and up through Beaumont. We wish we had it inland.

MR. BEAVIN: I think that I might ask

either Mr. Smith or Mr. Cooper of the Dow Chemical Company about this. They have a problem in that same area; and having talked to them about it a little bit, I think they feel the same way. Isn't that right?

MR. COOPER: That is right.

MR. BEAVIN: Whenever the control is within a reasonable distance, so that they can tie in to it without excessive cost, they welcome it and will use it.

MR. LAIRD (American Telephone): I would like to urge some of the government agencies to use their own control. This is a needling question. I find very frequently, in extending from Coast and Geodetic Survey and other control to radio stations scattered throughout the country, that you frequently have to carry two types of control for very great distances and in some instances the leveling parties have gone right by these triangulation monuments and failed to establish any elevations on them. In fact, I found them 6 feet apart in some instances. In expanding that control you frequently have to carry one long expansion for triangulation and another long expansion for leveling. I have found in some cases, after wandering around for a few days at different agencies, that those agencies are trying to collect from you the information which the other government agencies have. There is need for some system for exchanging that information.

MR. BEAVIN: I don't know whether any one of our panel members is particularly well qualified to talk about why the government does these things. How about you, Mr. Simmons?

MR. SIMMONS: He has a point there, all right. The Army Map Service has the control of all the surveying agencies. It is the only real center now. But people in civilian life don't know about it. It has been suggested that we take it over. We would if we had the manpower. Then anybody could come to us for all the Federal control. As it is now, no one person or one agency knows what the other organization knows. He has a good point.

CAPTAIN GARNER (Formerly of the Coast and Geodetic Survey): I would like to say a word with regard to Mr. Hough's paper, particularly his mention of cooperation and the attempt to avoid duplication, which also ties in directly with what the representative of the telephone company said with regard to this matter of benchmarks and triangulation stations so close together that the surveys obviously have not been properly coordinated. First, this matter of duplication. One instance of that was found in Hawaii. I don't know who established the first station on a hill out there. I think it was the Coast and Geodetic Survey in the original survey. Later on the Territorial surveyor, I think, went up to establish some control of his own and used the station. Then the Corps of Engineers, to make a reconnaisance military map, went up to the same point and presumably could not find the old station. It was a bad place to mark, and the marking had been done poorly. Of course, that usually is the case at the beginning. So a new station was established. In 1926 I happened to be in charge of some combined operations out there and had occasion to tie in the whole island system with the new triangulation scheme because the former was in bad shape and had been so reported for many years. We went up on this hill and there were four stations there. Well, I don't remember the details of how they came about, but principally it was because the stations were not properly marked and described. Each new surveyor who ascended that summit had set his own monument.

CAPTAIN HOSKINSON (Coast and Geodetic Survey): There have been many instances where different organizations have established the same type of marks on the same hilltop within a few yards of each other and they did not know that other marks were there. Every effort is being made at the present time, when instructions are given to a party going out in the field to run levels, triangulation, or traverse, to contact all of the agencies that could have done work in that area, both Federal, State, and local, and to get from them descriptions of their stations, locations of those stations, and to request the cooperation of those people. Any party of the Coast and Geodetic Survey going into the field has standard instructions to contact State, city, and county engineers; the engineers of the Geological Survey in that area and of any other agencies that might have marks or surveys in that area.

I am sure we are making great progress along that line at the present time, and everybody is more educated now as to the need of surveys and markers than they were before. Particularly in the preservation of monuments, we have now whole-hearted cooperation from engineers in all parts of the country, especially the highway engineers in the various States. I would say, on an average, that between two and five letters pass over my desk every day going to local engineers asking them to relocate one

of our benchmarks and preserve it for future use of the engineers. And we have the names of many hundreds of city, county, and local engineers in our files who we know will aid us in preserving these valuable triangulation marks and benchmarks. We write them letters when a mark has to be moved in their immediate vicinity and ask them to cooperate. We send them the mark with instructions on how to relocate it, break out the old one, and return it to us.

MR. HOUGH: Mr. Chairman, Mr. Simmons referred to the use of State coordinates for property surveys. I want to point out one instance I know of, the Pittsburgh Flood Control District, which had some eight or ten different reservoirs. There were many deeds to be prepared, as you can well realize, in taking over the property for flood control. The policy was adopted to write in the deed the State coordinates of one of the points of any traverse surrounding the property. Also, the State grid azimuths were used. That is right in the deed. This is an example where property surveys are definitely based on the State Coordinate System.

MR. SIMMONS: That also applies to the TVA. That was forced by the Federal set-up rather than accepted by the local surveys, but it is used, all right.

MR. KOCK: One phase of my job is to develop and coordinate airport plans for the City of Cincinnati. We have found the State Coordinate System, in the establishing of coordinates on the control plans for runways, to be almost indispensable. It makes everything so easy as to the determination of the azimuth of runways. I hope every State will eventually adopt such a system.

MR. SMITH: (Michigan): I have heard considerable comment with which I am in complete agreement about the desirability and the economic advantage of having a State Plane Coordinate System, and the remarks have been very encouraging for anyone who has been able to use this program. I am wondering, though, if there is anyone here who has had a part in the organization and the public education that was necessary before the enabling legislation was passed to get a Plane Coordinate System adopted in any given State. We have all the information in Michigan. I know that the members of the faculty in the State schools are highly in favor of it. We have had discussions in our own society meetings. The title association is beginning to be very conscious of it, and I think some members of the bar are beginning to toy with the idea. But I am wondering if someone can give us just a little history of how the public relations or public education has developed in a given State prior to getting sufficient interest in the legislature to pass the enabling legislation.

MR. BEAVIN: I take it you are interested in this question more or less from the local standpoint than from the Federal. I think either Mr. Blanchard or Mr. Houdlette, or both, would be very good members to bring out that aspect of it rather than one of our panel members who may have a somewhat different approach.

MR. BLANCHARD: In New Jersey, unfortunately, I am not in charge of surveys for the State Highway Department. If I were, I am sure that all our highways in New Jersey would be tied in to the State Coordinate System. However, I have found that as our control becomes more and more available, the engineers and the Highway Department and the other agencies are utilizing it. In any major project, such as our New Jersey Turnpike, which was a rush job, all available field survey parties were put to work. They started at a dozen or more points. That was all tied in to our control system, and it saved a lot of money. Our State parkway, which is under construction now and runs the entire length of the state, is also being tied in to our New Jersey Coordinate System, and in connection with the Garden State Parkway, all of the property they are acquiring for the right-of-way for this project is being tied in to the State Coordinate System.

As far as educating the public, it is a slow process. It takes time and it requires more of this control to be available to those who have a need for it.

MR. WHITTEN (U. S. Coast & Geodetic Survey): If Professor Egner is here, perhaps he could tell us what was done in Indiana to get the legislation enacted.

CAPTAIN HOSKINSON: This is not directly related to this subject, but Professor Egner has asked me to publicize the fine recovery system that we have for people who have visited our triangulation stations and benchmarks. We have a special recovery card on which anybody who visits our marks can report on the condition of that mark, and this enables us many times to save a mark which is beginning to deteriorate. Frequently, also, the conditions around the mark have changed so that the original description no longer fits it. Here again we have the cooperation of the engineers throughout the Nation.

MR. WALKER (Greensboro, N. C., Engi-

neering Department): We have had a coordinate system since 1922. Instead of doing the work itself, Greensboro hired Randall and Company to come in and set up the Plane Coordinate System. Since then, some of the monuments have been lost and little has been done to preserve those that remain. It is also in need of extension. I am wondering what system Cincinnati has for keeping their coordinate system in shape.

MR. KOCK: Cincinnati had a similar problem. The first real coordinate system was established in 1912. That was a local grid system based on the center point of the city, Hughes High School, on which was situated a triangulation station of the Coast and Geodetic Survey. That system was not maintained. The chief difficulty was that it was not brought to the ground in a number of cases. Horizontal control, as I said, was not used a great deal in Cincinnati. The vertical control is used every day, but horizontal control was not used until we initiated this State Plane Coordinate System. At that time we just took over the old monuments, calculated State coordinates for them, and expanded the system. We have an excellent eight-man traverse crew, angle crew, and level crew, and they have shown remarkable speed in acquiring and developing the necessary skill to run in the secondary control.

MR. BEAVIN: I have used this illustration in talking to people a number of times and it seems to be pretty effective. It is this. A survey system should be designed with about the same degree of care as a water system or power distribution system. It should be constructed carefully. After it is constructed, it should be given maintenance just the same as any other utility. It is just as valuable in its way as any other utility.

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Semigraphic Adjustment for Street Centerline Surveys

By H. L. THOMSON

LOS ANGELES DEPARTMENT OF PUBLIC WORKS

WHEN MAKING a street centerline survey in hilly territory, with curved streets and short courses, the problem of making changes fit the evidence found, and yet not departing too far from the record, is made difficult by the continuous changes in direction.

It is impossible to keep all this data in mind in its varying orientation and obtain a satisfactory solution.

However, if the evidence—L.&T.'s, stakes, I.P.'s and curb offsets—is placed on a plat to scale as the line is run, a much clearer picture can be obtained, and the effect of changes is more readily determined. Tract maps or district maps make a good plat upon which to place the evidence, which is replatted at a much larger scale, such as 1 inch = 0.20 foot, at each particular point where it is taken.

The possible combinations and variations are so numerous that no set of rules can cover them. The principles of the method can, however, be shown by an example (*see* figure) in which some definite assumptions must be made.

The example deals with the position of a street that has not been centerlined and starts and ends on previous centerline survey work. The line *MNO* is regarded as fixed, being determined on strong evidence by previous centerline survey. At the three-street intersection at *C*, by previous work, the angle *DCE* was held record. The angle formed by the new traverse coming into *C* from *6B* will be made record if possible in the adjustment, to avoid changing the complicated record property curves.

GRAPHING THE ADJUSTMENT

(1) Starting at *O*, using record centerline distances and angles, the centerline is laid out to point *7*, which point by the record map should be the same as the junction point *C*. From this point *7*, right angle offsets are taken to *C*, so that *C* may be platted on the enlarged scale in its existing relation to point *7*. Similarly all previous centerline points found, as well as all other evidence, are located with respect to the centerline points as laid out and are platted on an enlarged scale at the respective locations on a district or tract map. The angle between the traverse brought forward at *7* and the fixed direction *CD* was measured 42 seconds large of record.

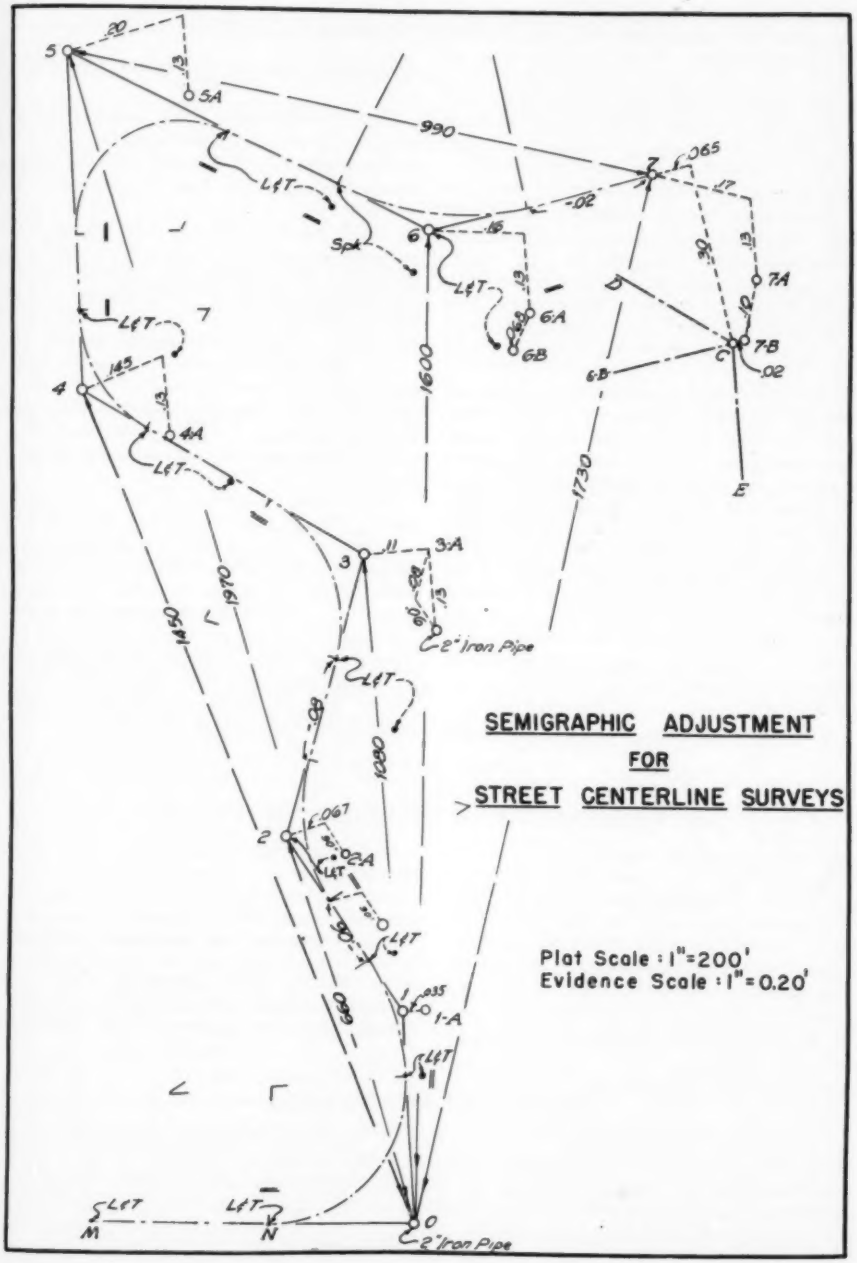
(2) A study of the platted evidence shows that the centerline, as run out by record, should be swung clockwise, pivoting on *O* and that probably the 2-inch I.P. at point *3*, being of record and solidly placed on a ridge, should be held.

(3) Draw a ray from *O*, where the swing is to start, to point *3* and a ray arc at point *3* at right angles to *O3*. On this enlarged scale the ray arc for short distances will be a straight line at right angles to the ray. Draw a line through the platted position of the 2-inch I.P. parallel to the ray *O3*, intersecting at *3A* the ray arc. Point *3* to *3A* scales 0.11 foot. The ray *O3* scales 1,080 feet. Dividing 0.11 by 1,080 gives an arc of 21 seconds.

The swing to the right, pivoting at *O*, will decrease the record angle at *O* and make a small change in the record radius. The semitangents are held record so that the property arcs will be changed but slightly.

(4) The shrinkage necessary in the lines *1-2* and *2-3* to make the point *3A* move down 0.13 foot to the 2-inch I.P. can probably best be put in the tangents of *1-2* and *2-3*. It is determined as follows: From the 2-inch I.P. draw a line parallel to *1-2* and from *3A* draw a line parallel to *2-3*. The scaled correction to be placed in the tangent *1-2* is – 0.06 foot and in the tangent of *2-3*, – 0.08 foot.

(5) To find the new position of point *2*, draw the ray *O2*, which scales 660 feet. The amount of the swing to the right at 90° to the ray will be 660 feet times arc 21 seconds or 0.067 foot. Then plat the shift of – 0.06 foot from the end of the swing parallel to *1-2*, which gives the


SEMIGRAPHIC ADJUSTMENT
FOR
STREET CENTERLINE SURVEYS
Plat Scale : 1"=200'
Evidence Scale : 1"=0.20'
990
1600
1730
1970
1450
1230
660
2" Iron Pipe
2" Iron Pipe
LFT

new position of point *2*. The graph shows that this point has moved until it is very close to the local evidence. Point *1* gets a swing of 0.035 foot to the right.

(6) Since the 21-second swing about the initial point *O* has rotated the entire centerline, the swing of 21 seconds to the right has moved point *7*, 1,730 feet times arc 21 seconds, or 0.17 foot, at right angles to the ray *O7*. Next the 0.13-foot shift, *3A* to 2-inch I.P., is platted from the end of the swing, parallel to *O3*, which brings point *7* to point *7A*.

(7) Find the new positions for points *4*, *5*, and *6* in the same manner. The evidence, considering the movement of concrete pavement in the hills, has been reasonably met up to point *5*.

(8) There is still 21 seconds of the clockwise swing to be used. With a 990-foot ray from point *5* to point *7*, a 21-second clockwise swing will move point *7A*, 0.10 foot at right angles to ray *5-7*, to point *7B*, close to the final point *C*, as well as giving a record angle at the three-street intersection. The record angle at point *5* will be increased 21 seconds. The semitangents are held and the radius changed. By a ray *5-6* and the 21-second swing, the point *6A* is moved 0.068 foot to *6B* and its close meeting of evidence shown.

(9) Shortening the tangent in line *6-7* by 0.02 foot will make the final closure, placing *7B* on *C*.

(10) The offsets and distances to evidence from the final adjusted positions can be readily scaled from the graph with sufficient precision.

PLACING THE ADJUSTMENT ON THE GROUND

(11) The right-angle offsets and distance of each finally adjusted point from the point as first run in by record are scaled from the graph with reference to the back-tangent line produced.

(12) A pencil line on the back-tangent line produced is drawn on the pavement and the position of the adjusted point determined by right triangle and scale. For example, point *4A* is 0.165 foot back from point *4* on line *4-3* and is 0.015 foot to the right of this line.

(13) The angles between the adjusted points are checked by doubling to see that no error has been made. The semitangents are set and the tangent lengths checked as the work progresses, to see that they agree with the changes made in the adjustment.

(14) In this adjustment, but two slight angular changes from record have been made, and property frontage has been shortened only where justified by substantial evidence. A considerable part of the traverse has been held record and a record angular connection made, preserving a complicated intersection. At all times the surveyor can see clearly the effect of any change on the whole line and on the closure and can also see where changes will be most effective to fit the groups of evidence.

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[1] W. & L. E. Gurley, Troy, N. Y.

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Land Is a Precious Thing

By THOMAS R. NEWTON

DEPARTMENT OF CIVIL ENGINEERING, AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

IN EUROPE, land is a precious thing. The population is dense and the farms are small, and every square foot of the land must produce. Small pieces of ground are handed down from generation to generation, and the members of the family are intimately acquainted with every rock and blade of grass on their property. It is their own little world—something sacred.

Even in the early days of Texas, land was a precious thing, although it seemed to be unlimited. The first settlers thought nothing of owning 5,000 or 10,000 acres and being familiar with every tree within their boundaries.

A legal document, dated July 1824, in which the Mexican Government granted Robert Millican some 11,000 acres of land in this county, reads partly as follows:

> . . . We put the said Robert Millican in possession of said tract of land, taking him by the hand and causing him to walk around it and telling him in loud and audible words, that by virtue of the commission and powers in us vested in the name of the Government of the Mexican Nation we put him in possession of said tract of land with all the uses, customs, rights, and services thereof, unto him, his heirs and assigns; and the said Robert Millican, in evidence of being in real and personal possession of said tract of land, without any contradiction, cried out, pulled twigs, threw stones, drove stakes, and performed the other necessary solemn acts. . . .

These "necessary" and "solemn" acts, though they sound silly today, serve to illustrate the importance once attached to the ownership of land.

Also, I am told that some sect in the eastern part of this country once set aside one day a year, at which time the children of the family were taken around their land and the boundaries and corners were pointed out to them.

Originally presented to a local civic organization in Bryan, Tex., on March 2, 1950.

Times have certainly changed! Land in this country, still being in comparative abundance, has become not much more than a commodity—something to be bought and sold. We use part of it, waste most of it, and generally pay little attention to it. If it *is* a commodity, it is a rare one, for no more of it is going to be manufactured!

I ask you this question: How many people could take their children around their property and show them exactly where the corners are?

Your guess is as good as mine on how many houses and improvements in the average city are wholly or partly located on the wrong lot. But I think I can safely say, based on my observations, that there are hundreds of them. How many neighbors are there who would be friends were it not for arguments over their boundaries?

Let's look at some of the reasons for these conditions. First and foremost is the apparent lack of pride in ownership. When the first markers were set by the original surveyor, they were indifferently left to rot or be destroyed. Now these original boundaries and corners are most important, because legally they may not be changed except by agreement of adjacent property owners *or* by action through the courts. Those who built fences or planted hedges on their lines were at least temporarily more fortunate. Nowadays we are prone to buy land without even knowing where it is or how much of it there is. We buy 100 acres, not knowing whether there are 50 or 150 actually there. The same is true of a city lot; in many cases we buy arguments without knowing it.

The second reason is the fault of the original surveyor. It was his duty to leave written or platted records with sufficient information so that any surveyor could subsequently re-establish those corners if they were lost or destroyed. The information

they left has varied from no records at all to very complete and accurate ones. Most of the original ones, however, have been incomplete and inaccurate. Although many of our pioneer surveyors were laboring under hardships and without adequate equipment and training, the fact remains that we have inherited these shortcomings.

Now, let us consider the third and most important reason—the problem of the surveyor who is called upon to re-establish those lost boundaries. His duty is to relocate them exactly where they were first set by the original surveyor—or we often say, ". . . to follow in the footsteps of the original surveyor." It is our problem, as surveyors, to determine his probable errors, piece together the fragments of his records, and yet arrive at the same lines and corners that he originally set on the ground. This is the most difficult task of all! And frankly, sometimes it is an impossible one; when the recorded information is grossly incomplete it takes the utmost in training, skill, ingenuity, and patience to retrace those old lines; and the surveyor who does not have those qualifications can cause trouble.

It is in all three reasons that our problems lie. We, today, have no control over the work done by those in the past. It is with the surveyor of today that the practical responsibility rests. He should be a person capable of meeting his responsibility.

Advice is cheap, so I offer this suggestion: If you are going to buy land, whether it is 5,000 acres or only a small city lot, *know what you are buying!* Don't buy trouble! Have it checked by a competent surveyor.

It just cannot be right to be careless with something which so many people cherish!

* * *

Telecurve World Maps

GREAT CIRCLE distances and courses are readily obtainable with a new series of telecurve world maps recently developed by Felix M. Locher, Hollywood, Calif. A standard Mercator chart of the world is used for the base which is common to a number of individual charts centered at principal cities of the world. True global relationships are effected by a route pole, anti-pole, and two sets of "telecurves"—the route-curves and the distant curves. These special features are applied to the map for any designated center, thus providing a means of overcoming the distortion inherent in the Mercator Projection.

The route-pole is identified by a small diamond-shaped symbol placed at the initial point of reference on each respective map. Visualizing the global relationship to be portrayed, an anti-pole is placed at a point exactly opposite the route-pole. This point, "halfway around the world" from the initial point of reference, is indicated by a small circle. Actually the route-pole and anti-pole represent points which, on a globe, are diametrically opposite one another.

The route-curves are shown as a series of sweeping lines radiating from the route-pole and extending to the anti-pole. They spread apart as they leave the route-pole and come together as they approach the anti-pole where all route-curves meet. The total air line distance between the route-pole and anti-pole is about 12,430 statute miles regardless of the route-curve followed. Thus these lines represent the great circle routes or shortest possible routes running in all directions from the route-pole to places throughout the world. The shortest distance between two chosen places is determined by finding the route-curve common to both.

The distance-curve of a telecurve map consist of a series of heavier lines surrounding the route-pole and crossing the route curves at intervals of 500 or 1,000 miles. The distance-curves are numbered beginning at the route-pole with values in statute miles representing airline distances from the route-pole to all points on the same distance-curve as measured along the route-curves (great circle routes). The telecurve maps also show the international date line and the twenty-four standard time zones for determining comparative standard time and dates. —*The Military Engineer,* Vol. XLIV, No. 299, May–June 1952.

You Can't Build That Mosque With a Compass

By DON MAY

THE MOSQUE on Massachusetts Avenue [in Washington] faces 56 degrees, 33 minutes, and 15 seconds east of true north, and thereby hangs a minor tale.

The direction is toward Mecca, which all mosques must face with mathematical exactness. It was calculated for this mosque by the Egyptian Ministry of Works in Cairo. Egypt is one of the Moslem countries sponsoring the mosque. The Egyptian Ambassador is president of the organization building it.

Passersby—many of them Moslems—keep dropping in, and some of them have come up with a frightening thought. The direction 56-33-15, they pointed out, was slightly north of east. But Mecca, the Moslem holy city in Arabia, was south of Washington. (Washington—38 degrees, 55 minutes. Mecca—21 degrees, 25 minutes.) Take any map, they said, and draw a straight line between the two cities and the line would go slightly south. But the mosque pointed slightly north.

The trouble was easily explained. The visiting Moslems had been thinking in terms of the standard Mercator projection map. On such a map the straight line *would* go slightly south, but it would not be the shortest distance to Mecca. The shortest distance, as an air age knows, would be a great circle route, easily seen on a globe or on a special flat map called a "gnomonic projection," heading slightly north to start with, passing near New York, Halifax, and along the North Atlantic iceberg lanes on its way across the world. It was like the great circle route suddenly coming to the Moslem world—except, of course, that Moslems drawing circles in the sand centuries ago had known about it all along.

Then there was the disturbing day when Egyptian Ambassador Mohamed Kamil Abdue Rahim visited the mosque. He stood in the center of the great, half-completed structure with a pocket compass in his hand. He stared and shook his head and said:

"It points so far north."

Architect Irwin S. Porter said he explained to the Ambassador that the compass pointed toward the false magnetic north and has—among other things—a seven-degree westerly variation error in it."

Even so, the Ambassador began telling the architect a little story. In Egypt when they build a mosque, the story went, they gave the builders a point to sight on. Then when the building was done, the royal engineers came out and surveyed. And if it wasn't right, the builders had to tear the whole works down and build it over again.

"I'll tell you, it gave me a few nights of worry," Mr. Porter said.

Mr. Porter called up a cartographer, Wellman Chamberlin, of the National Geographic Society, and asked him "just for formality" to check the direction of Mecca.

"He called back in a few hours," Mr. Porter said, "and of course it was right—56-33-15."

Mr. Porter asked the cartographer: "But how can I explain this to the Ambassador?"

"Tell him to take a globe," was the cartographer's advice, "and two thumb tacks, one at Washington and one at Mecca, and to run a string between and he will see that that is the direction of Mecca."

Mr. Porter's own office made up the globe with the tacks and string and sent it to the Ambassador.

"The Ambassador now is very happy," said Mr. Porter.

The News called the embassy and brought up the general subject with the third secretary.

Reprinted from *The Washington Daily News*, April 15, 1953.

"Well, the direction is 56 degrees, 33 minutes, and 15 seconds," said the third secretary. "It was calculated by the Egyptian Ministry of Works in Cairo. There can be no dispute about it."

"It's very simple," he went on, "Anyone can demonstrate it. Just take a globe and two thumb tacks and . . . ."

The Surveyor's Novelty

In the Texas General Land Office Archives in Austin is a letter filed in June 1881 from Henry J. Schley to Commissioner W. C. Walsh. Schley was an ex-county surveyor of Wharton County at that time and in his letter discussed the troubles of Surveyor George Turnbull who feared the loss of his land certificates by not complying with the requirements of the Land Office to make returns by January 1, 1875 "unless he chimney cornered" his surveys. Schley also told the Land Commissioner: "I do not like to poke in my mouth but would inform the Land Office that the present County Surveyor has a novelty in the way of a surveyor's compass—only one end of the needle is magnetized and his sight bars were made in the Blacksmith in Wharton out of the best refined steel. This is a fact. *Ab uno disce omnes.*" (From one specimen, judge all the rest.—Ed.)

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Tam McArthur Rim

By HAROLD R. BROOKS

U. S. COAST AND GEODETIC SURVEY

THE MEMORY of the late Lewis A. McArthur, formerly a Regional Vice President of the American Congress on Surveying and Mapping, has been honored recently by the Board of Geographic Names. A prominent feature in his native State has been named after him, using the nickname "Tam" by which his friends will always remember him.

Tam McArthur was born in The Dalles, Oreg., in 1883. His nickname was acquired in his childhood from a Chinese houseboy. He received his early schooling in Portland and his higher education at the University of California. After graduation in 1908, he returned to Portland to take a position with the Oregon Electric Railway. In 1910, he accepted a position with the Pacific Power and Light Co. His rise within that organization was very rapid and by 1922 he was a director and vice-president of the company. He retained the latter position until his retirement in December 1948.

LEWIS A. "TAM" McARTHUR

Besides his primary interest in the uses of electric service, McArthur delved into the fields of history and geography, particularly as related to his own State, to the extent that he became a leading authority on these subjects. He published his "Oregon Geographic Names," now a standard reference book, in 1928 and revised it in 1944. He collaborated with the U. S. Coast and Geodetic Survey and with the Forest Service and was consulted during the war as a map authority by the Army.

Tam McArthur had a remarkable ability to read at great speed, to absorb all the vital information, and to remember the facts years later. These abilities plus a tremendous power of analysis and remarkable intellectual energy made him much sought after by numerous clubs and societies. He joined many of the organizations that were closely related to his best-loved subjects and he remained active in them until shortly before he passed away on November 8, 1951, an illustrious citizen of the State of Oregon.

For over a year the Board of Geographic Names has been endeavoring to find a monument worthy of Tam. Friends from various parts of the State suggested the renaming of numerous features known to be well-loved by him. However, all his close associates realized that he would have been the first to protest the changing of an established name just to honor him, even though he was practically a pioneer.

Early this year an appropriate feature, still unnamed, was located in Tam's beloved Oregon. On the northeast side of Broken Top Mountain, approximately eighteen miles west of Bend, is a majestic three-mile-long, crescent-shaped ridge overlooking Three Creeks Lake at an elevation of 7,740 feet. This eminence has been selected to

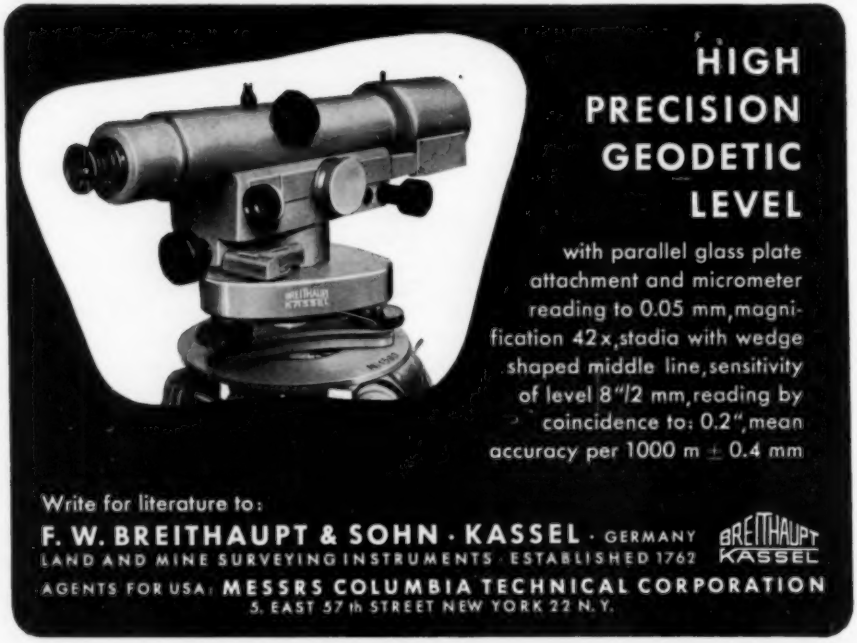
become the memorial to perpetuate the name of Tam McArthur, as an expression of gratitude and appreciation for a life of service to his State and his Country. This beautiful and noble feature will henceforth be known as "Tam McArthur Rim."

New Editions of Lake Survey Charts

The United States Lake Survey of the Corps of Engineers, U. S. Army, has announced the release of new editions of the following Lake Ontario and St. Lawrence River charts: No. 18, St. Lawrence River, Cape Vincent, N. Y. and Howe Island, Ont., to Allen Otty Shoal, N. Y., and Ninemile Point Light, Ont., at a scale of 1:30,000; No. 21, Coast Chart, Clayton, N. Y., and Kingston, Ont., to Stony Point, N. Y., and False Duck Islands, Ont., at 1:80,000; No. 22, Coast Chart, 6 miles south of Stony Point, N. Y., to 8 miles west of Little Sodus Bay, N. Y., at 1:80,000, with an inset of Little Sodus Bay at 1:15,000; and No. 23, Coast Chart, 8 miles east of Sodus Bay, N. Y., to Rochester Harbor, N. Y., at 1:80,000.

The edition date of all four charts is July 1953.

Copies of the above charts may be procured from the U. S. Lake Survey, 630 Federal Bldg., Detroit 26, Mich. The cost is 75 cents each and payment in advance is required with the order, by P. O. money order or draft, payable to the Treasurer of the United States. Shipments are made promptly, postage free.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Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

In the present issue of "Current Surveying and Mapping Literature," an effort is made to classify the periodical items according to the primary interest of the various Divisions of the Congress—following a group under the heading of "General Interest." Of course, such a classification cannot be rigid because most articles carry an overlapping of interests, and, certainly, a majority of them could well be included under "General Interest." Comments on this form of breakdown are invited.

MAGAZINE ARTICLES

General Interest

HISTORY OF PHOTOGRAMMETRY IN THE UNITED STATES. David Landen. *Photogrammetric Engineering,* Vol. 18, No. 5, December 1952. (Comprehensive history of the subject arranged to cover Government, Commercial, and Educational and Scientific activities in the field.)

PHOTOGRAMMETRY AIDS HIGHWAY ENGINEERS. A. O. Quinn. *Photogrammetric Engineering,* Vol. 18, No. 5, December 1952. (Address before the Western Association of State Highway Officials, Seattle, Wash., June 6, 1952.)

THE ENGINEER AND HIS ENGLISH. Dr. Alvin M. Fountain, Professor of English, North Carolina State College. *North Carolina Engineer,* Vol. 9, No. 2, January 1953. (A plea for better oral and written expression by engineers and some suggestions for their improvement.)

THE HISTORY OF PHOTOGRAMMETRY IN CANADA. R. H. Field. *The Canadian Surveyor,* Vol. 11, No. 3, January 1953.

TRIALS OF A SURVEYOR—MODERN VERSION. John B. Alexander. *Empire Survey Review,* Vol. 12, No. 78, January 1953. (Surveying adventures in Africa—interesting reading.)

SURVEYS IN THE ROTORUA-TAUPO-BAY OF PLENTY REGIONS. R. G. Dick, Surveyor-General. *New Zealand Surveyor,* Vol. 20, No. 9, February 1953. (A report on the organization and accomplishments of various kinds of survey operations in an area containing some of the richest potential resources in New Zealand.)

MAKING THE SEAS SAFE FOR NAVIGATION. Captain R. Barry O'Brien. *Nautical Magazine,* Vol. 169, No. 2, February 1953. (A discussion of the work and products of the British Hydrographic Department.)

HE HAS COUSINS BY THE DOZENS. Staff Article. *The Lamp,* Vol. 35, No. 1, March 1953. (Human interest story of the operations of right-of-way men for a leading pipeline company in obtaining easement contracts from property owners.)

PROFESSIONAL LICENSING LAWS ATTACKED. News Item. *Engineering News-Record,* Vol. 150, No. 12, March 19, 1953. (Colorado courts throw out both engineers' and architects' licensing laws—Connecticut considers amendments—New York delays action on corporation practice.)

GEORGE WASHINGTON. (Item in "Pages des Jeaunes") *Revue des Geometres-Experts et Topographes Francais,* 114th year, No. 4, April 1953. (Discussion, in French, of Washington's role as a land surveyor during his early life.)

WHAT IS THE FUTURE OF PHOTOGRAMMETRY? A. O. Quinn, President, American Society of Photogrammetry. *The Canadian Surveyor,* Vol. 11, No. 4, April 1953. (Address presented before Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, Ottawa, January 1953.)

SCIENTISTS *CAN* TALK TO THE LAYMAN. John W. Hill and James E. Payne. *Science,* Vol. 117, No. 3042, April 17, 1953.

SOME COMMENTS ON POPULAR-SCIENCE BOOKS. John Pfeiffer. *Science,* Vol. 117, No. 3042, April 17, 1953. (Comments on popular-science books of recent date and their varying success in carrying their messages to the public.)

A NOTE ON ISLAMIC ASTRONOMY. Lieut.-Col. W. A. Garstin, C. B. E. *Empire Survey Review*, Vol. 11, No. 85, July 1952. (Discussion of the work of Arab astronomers and mathematicians during the middle ages and their indebtedness to earlier Greek studies.)

CAPTAIN WILLIAM BLIGH, R. N., HYDROGRAPHIC SURVEYOR. A. H. W. Robinson. *Empire Survey Review*, Vol. 11, No. 85, July 1952. (Describes the little-known activities of Bligh as a surveyor between the years 1797 and 1804.)

Cartography

XVIth CENTURY CARTOGRAPHY IN THE NETHERLANDS. Johannes Kuening. *Imago Mundi*. 9. 1952.

THE FIRST RUSSIAN MAPS OF SIBERIA AND THEIR INFLUENCE ON THE WEST-EUROPEAN CARTOGRAPHY OF N. E. ASIA. Leo Bagrow. *Imago Mundi*. 9. 1952.

MAP OF JAPAN BY FATHER GIROLAMO DE ANGELIS. Joseph F. Schutte. *Imago Mundi*. 9. 1952.

LA CARTA GEOGRAFICA DEL MUNICIPIO DE VERACRUZ. Ing. Ernesto Dominguez A. *Boletin de la Sociedad Mexicana de Geografia y Estdistica*, Vol. 73, Nos. 1–3, January–June 1952. (Account of new map of the city of Veracruz for use in connection with the census of 1950 and for general statistical and planning purposes.)

AERIAL PHOTOGRAPHS IN FOREST MANAGEMENT. Stephen H. Spurr. *Photogrammetria*. Vol. 9, No. 2, 1952–53.

A TRANSVERSE MERCATOR PROJECTION OF THE SPHEROID ALTERNATIVE TO THE GAUSS-KRUGER FORM. L. P. Lee, Lands and Survey Dept., Wellington, N. Z. *Empire Survey Review*, Vol. 12, No. 87, January 1953. (Mathematical discussion of the properties of a projection somewhat similar to the Gauss-Kruger projection which, the author believes, should be the proper name of the "Transverse Mercator" projection.)

EMPLOI DES PROJECTIONS CONFORMES EN CARTOGRAPHIE. A. Gougenheim, Chief de la Marine, Paris. *Bulletin Geodesique*, N. S. Annee 1953, No. 27, 1 Mars 1953. (Consideration, from the cartographic point of view, of the conformal representation of the sphere. In French with German, English, and Spanish summaries.)

PANEL ON ARCTIC MAPPING. Marc Boyer, Deputy Minister of Mines and Technical Surveys, Ottawa, Moderator. *The Canadian Surveyor*, Vol. 11, No. 4, April 1953. Papers presented: "The Contribution of Explorers to the Mapping of Arctic North America," Norman L. Nicholson. "Arctic Air Photography, R.C.A.F. Photo Equipment and Techniques, Part I," W/C R. I. Thomas. "Arctic Air Photography, R.C.A.F. Photo Equipment and Techniques, Part II," W/C D. S. Ross. "Arctic Mapping—Aerial Photography," Lt. Col. Paul E. Gremmler. "Control for Arctic Mapping," C. H. Ney. "Charting Northern Seas and Harbours," F. C. G. Smith. "Hydrographic Surveying in the Arctic," Lt. Comdr. T. K. Treadwell. "Arctic Mapping," B. W. Waugh. "Mapping in Arctic Alaska," Gerald FitzGerald. "U. S. Mapping in the Arctic and Sub-Arctic Regions of the Western Hemisphere," Albert L. Nowicki. "Horizontal and Vertical Control for Arctic Mapping," Comdr. Hubert A. Paton.

Control Surveys

TRIGONOMETRICAL HEIGHT RESECTION. Major H. A. Johnson and G. J. Thorton-Smith. *The Australian Surveyor*, Vol. 13, No. 8, December 1951. (Idea whereby both difference of height and coefficient of terrestrial refraction may be obtained from vertical angles observed at a standpoint, whose R. L. is sought, to several trigonometrical stations whose positions and R. L.'s are known.)

TIDAL DATUM PLANES. C. M. Cross. *The Canadian Surveyor*, Vol. 11, No. 2, October 1952. (This paper, presented at the Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, February 1952, is a comprehensive explanation of the various datum planes and the relationship between them.)

CONTROL EXTENSION BY PHOTOGRAMMETRIC METHODS. Lewis A. Dickerson, Army Map Service. *The Canadian Surveyor*, Vol. 11, No. 3, January 1953. (Paper presented at Annual Meeting, Canadian Institute of Surveying and Photogrammetry, February 1952.)

CONTROL SURVEY COMPUTATIONS. R. M. Wilson. *The Canadian Surveyor*, Vol. 11, No. 3, January 1953. (Paper presented at Annual Meeting, Canadian Institute of Surveying and Photogrammetry, February 1952.)

HORIZONTAL ANGLES IN TRIANGULATION: SOME PRACTICAL SUGGESTIONS REGARDING THEIR OBSERVATION AND ADJUSTMENT. J. H. Cole. *Empire Survey Review*, Vol. 12, No. 78, January 1953. (Consideration of the two methods of observing horizontal angles in the field with practical suggestions on setting up a theodolite followed by remarks on office adjustment of the observations.)

LEAST SQUARES ADJUSTMENTS OF TRIANGULATION: DIRECTIONS VERSUS ANGLES. H. F. Rainsford. *Empire Survey Review*, Vol. 12, No. 78, January 1953. (Continuation of the discussion started in an article of the same title in the "Review," Vol. 10, No. 78, October 1950.)

MEAN SEA LEVEL AND MEAN HIGH WATER MARK. L. P. Lee. *New Zealand Survey Draughtsmen's Journal,* Vol. 1, No. 9, January 1953. (An effort to clarify the concept of the datum by an explanation of how the level of the sea varies with the passage of time.)

PHOTOGRAMMETRY, SPECIFICATIONS AND PRACTICES FOR THE USE OF AERIAL SURVEYS. Edward T. Telford, Traffic Engineer, and L. L. Funk, Assistant District Engineer. *California Highways and Public Works,* Vol. 32, Nos. 1, 2, January–February 1953. (Paper presented at the meeting of the Committee on Design, American Association of State Highway Officials, December 12, 1952, describes practices developed in California.)

SOME NOTES ON COMPUTING. R. W. Pring. *Empire Survey Review,* Vol. 12, No. 88, April 1953. (General discussion with examples and formulae.)

Education

DOMINION TOPOGRAPHICAL SURVEYOR. John Carroll. *The Canadian Surveyor,* Vol. 11, No. 2, October 1952. (Discusses the high degree of proficiency required for the diploma in surveying, granted through examination, by the Government of Canada.)

THE COMMITTEE ON EDUCATION OF THE ONTARIO LAND SURVEYORS ASSOCIATION. W. J. Baird. *The Canadian Surveyor,* Vol. 11, No. 3, January 1953. (Includes requirements for admission to practice as an Ontario Land Surveyor.)

WHAT ARE THE UNIVERSITIES DOING IN TRAINING STUDENTS FOR THE SURVEYING AND MAPPING PROFESSION. Prof. George H. Harding. *The Canadian Surveyor,* Vol. 11, No. 3, January 1953. (Professor Harding describes the training afforded at the Institute of Geodesy, Photogrammetry and Cartography at Ohio State University.)

Instruments

NOUVEAUX INSTRUMENTS DE NIVELLEMENT. Dr.-Ing. M. Drodofsky, Heidenheim/Brenz. *Bulletin Geodesique,* Nouvelle Serie, Annee 1952, No. 25, 1 September 1952. (Communication du Laboratoire pour instruments geodesiques de la Firme Zeiss-Opton GmbH. In French. English version available from Zeiss agency, 485 5th Avenue, New York 17, N. Y.)

A NOTE ON THE WINTERIZATION OF SURVEY INSTRUMENTS FOR THE TOPOGRAPHICAL SURVEY. H. A. Munro. *The Canadian Surveyor,* Vol. 11, No. 2, October 1952. (Brief discussion of the Survey's use of "all temperature" lubricants and the technique of applying them.)

ALTIMETERS AS USED BY THE 30TH ENGINEERS FOR MAPPING. Col. Robert B. Robertson. *Photogrammetric Engineering,* Vol. 18, No. 5, December 1952. (Describes use of altimeters transported by helicopter in connection with difficult mapping project in Alaska.)

A METHOD FOR THE DETERMINATION OF THE DISTORTIONS OF THE IMAGE FORMED BY A MULTIPLEX PROJECTOR. A. M. Wassef, The Survey of Egypt. *Empire Survey Review,* Vol. 12, No. 87, January 1953. (A method is described for the determination of the resultant of the radial and tangential components of the distortion of the image produced by the Multiplex projector.)

Property Surveys

THE PRINCIPLES OF EVIDENCE. J. H. Holloway. (In section on "Provincial Survey and Mapping Activities, in the Province of Alberta.") *The Canadian Surveyor,* Vol. 11, No. 2, October 1952. (This article contains the subject matter of a lecture given by Mr. Holloway at a special course for Land Surveying Candidates arranged in April 1952 by the University of Alberta and the Alberta Land Surveyors' Association.)

DETERMINATION OF AZIMUTH AND LATITUDE FROM OBSERVATIONS OF A SINGLE UNKNOWN STAR BY A NEW METHOD. Sanjib K. Ghosh, Survey of India. *Empire Survey Review,* Vol. 12, No. 87, January 1953. (Mathematical discussion of a new method which author believes will be of value to land surveyors.)

99-YEAR AND 999-YEAR LEASES. "Of Interest" section. *New Zealand Survey Draughtsmen's Journal,* Vol. 1, No. 9, January 1953. (Speculation as to original reasons for adopting such figures in connection with land conveyances.)

THE TORRENS SYSTEM. P. S. Stewart, Master of Titles, Province of Saskatchewan. *The Canadian Surveyor,* Vol. 11, No. 3, January 1953. (A description of the Torrens System of land registration, which originated in Australia in 1857, and is now in use in the Province of Saskatchewan.)

Topography

CURRENT DEVELOPMENTS IN PHOTOGRAMMETRY IN THE UNITED STATES. George D. Whitmore. *The Canadian Surveyor,* Vol. 11, No. 2, October 1952. (Paper presented at the Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, February 1952.)

NORTHERN WINTER MAPPING. J. B. O'Neill. *The Canadian Surveyor,* Vol. 11, No.

2, October 1952. (Description of the winter operations of the Topographical Survey's field parties.)

A SURVEY CONTROLLED TEST AREA FOR MAPPING METHODS RESEARCH. John Carroll. *The Canadian Surveyor*, Vol. 11, No. 3, January 1953. (This paper, describing establishment and operation of a large control area, was presented at the Annual Meeting of the Canadian Institute on Surveying and Photogrammetry, February 1952.)

AERONAUTICAL CHARTING AND MAPPING. Charles A. Schanck. *Proceedings, American Society of Civil Engineers*. Vol. 79. Separate No. 172. February 1953.

THE ACCURACY OF TOPOGRAPHIC MAPS. Col. D. R. Crone. *Empire Survey Review*, Vol. 12, No. 88, April 1953. (An inquiry into the possibility of defining and laying down standards of qualitative, planimetric, and relief accuracy, and of devising a method of testing maps.)

BOOKS AND PAMPHLETS

AUSGEWAHLTE KAPITEL DER GROSSRAUMTRIANGULATION. *Veroffentlichungen des Instituts fur Angewandte Geodasie* (fruher Institut fur Erdmessung), No. 15, 122 pp., 1952. (Selected chapters in triangulation of extensive areas.)

CONFORMAL MAPPING. Prof. Zeev Nehari. (International Series in Pure and Applied Mathematics.) Pp. viii and 396. London, *McGraw-Hill Publishing Co., Ltd.*, 1952. (Combines an account of modern methods with a return to the spirit of early developers of the method; written for the physicist and engineer as well as for the mathematician.)

CONFORMAL PROJECTIONS IN GEODESY AND CARTOGRAPHY. U. S. Coast and Geodetic Survey, Special Publication No. 251. 142 pp., Washington, 1952.

CONFORMAL REPRESENTATION. C. Caratheodory. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 28). Pp. lx and 115. (Cambridge; at the *University Press*, 1952.)

PHOTOGRAMMETRIC MAPPING FROM AIR PHOTOGRAPHS: A SIMPLE EXPLANATION. Hunting Aerosurveys, Ltd. (the Technical Staff of). Pp. 54. (London: *Illiffe and Sons Ltd.*, 1952.)

UNIVERSAL TRANSVERSE MERCATOR GRID (Corrected to September 1951.) U. S. Department of the Army, Corps of Engineers, Army Map Service. (AMS Technical Manual No. 19.) 66 pp., map. Washington, D. C., 1952.

AIDS TO NAVIGATION MANUAL. United States Coast Guard. *U. S. Government Printing Office*, Washington, 1953. (A very comprehensive manual, issued in loose-leaf binding, which will be of interest to all hydrographic surveyors. A useful glossary of aids to navigation terms is included. Not all chapters have been published but will be added later.)

THE MAPMAKER'S ART: ESSAYS ON THE HISTORY OF MAPS. (With a foreword by Sir Thomas Kendrick.) 140 pp., maps. London, *Batchwork Press*, 1953. (A collection of articles reprinted from various sources, published between 1943 and 1950.)

ANNUAL PROGRESS REPORT OF THE COLORADO SCHOOL OF MINES. 38 pp., illustrated. (Detailed report on the instructional, personnel, public, and administrative services offered by the school covering a broad field of engineering as a whole as well as numerous specialized phases.)

RELIEFHERSTELLUNG, ANGLYPHENKARTEN UND PHOTOMECHANISCHE SCHUMMERUNG. M. Kneissl und W. Pillewitzer. *Deutsche Geodatische Kommission*, Reihe B: Angewandte Geodasie—Veroffentlichung Nr. 5, 27 pp., illustrated, map and anaglyph in pocket, 1952.

BETTER DEEP ETCH PLATES WITH HARRIS DEEP ETCH CHEMICALS. Harris-Seybold Company, Chemical Division. (This pamphlet, which may be obtained free from the Harris-Seybold Company, Chemical Division, 5308 Blanche Avenue, Cleveland 27, Ohio, describes and illustrates 15 steps in plate making.)

NEW PUBLICATIONS RECEIVED

PROGRESS IN RESEARCH. Quarterly publication of the Denver Research Institute of the University of Denver. Vol. 1, No. 1, May–June–July 1953.

REVISTA DE ENGENHARIA FOTOGRAMMETRICA. Published at Avenida Reboucas, 2682, Sao Paulo, Brazil. Trimestral. Partial contents of Vol. 1, No. 2: "Mosaicos Aerofotograficos," Engs. Antonio J. Nami e Zigmas Slepetys. "Anteprojetos e Coordenadas Geograficas," Eng. Aristeu dos Reis. "Levantamentos Aeros e Fotogrametria na Columbia Britanica," G. S. Andrews. "Exatidao ou Precisao—qual delas?", Paul H. Bonart. "Invacoes nas cameras aereas automaticas Wild," H. Kasper.

—LYMAN D. LYNN

DISTINCTIVE RECENT MAPS

For the reader's convenience, the addresses of publishers and prices of maps are given where this information is available.

—EDITOR

Two more plates of the American Geographical Society's "Atlas of Diseases" have recently been published. *Distribution of Leprosy 1952,* Plate 7 of the Atlas, was issued as a supplement to the January 1953 number of the *Geographical Review.* A brief description of the map, by Dr. Jacques M. May, is printed in the journal. Various areas of occurrence of leprosy are classified on the map as light, medium, and heavy, and these three groups are subdivided to show three gradations of density. Some 800 leprosaria, or centers of treatment, are also shown. From the map we note that the disease is most frequent in areas of warm and humid climate having dense populations and low standards of living. A table gives number of known and estimated cases of leprosy for every country. Leprosaria are listed, by country, on the verso of the map sheet. The Briesemeister equal-area projection is used for the map which has an areal scale of 1: 37,500,000.

Plate 8, entitled *Study in Human Starvation, 1, Sources of Selected Foods,* presents a series of three maps which show, in a general way, the distribution of the most important sources of the basic food elements. Map 1 shows sources of animal proteins, map 2 shows sources of cereal carbohydrates, and map 3 shows sources of other carbohydrates, such as roots and tubers, vegetable fats, sago, and some fruits. All three maps are at a scale of 1: 75,000,000. A smaller inset map shows populated areas of the world. Several tables fill spaces on the face of the map sheet and the verso gives production of selected foods by country. "The Mapping of Human Starvation," a brief description of the map, appears in the April 1953 number of the *Geographical Review.*

A new ten-color *Historical Map of the United States* was issued as the map supplement to the *National Geographic Magazine* for June 1953. Prepared to commemorate the 150th anniversary of the Louisiana Purchase, the map, by cartographic symbols and conventions, and 912 notes, tells the story of how our nation has grown to strength, prominence, and glory. Preparation of the map, described as "the largest —and pleasantest—project ever undertaken by the Society's cartographers," required a total of 7,764 hours of work by 17 members of the staff. The historical map is printed on a sheet measuring 26½ by 41 inches. Copies, at 50 cents, are available from The National Geographic Society. An enlarged edition, suitable for use as a wall map, (67 by 43½ inches) may be obtained at $2.00 per copy.

The June issue of the *National Geographic* also includes a series of colored facsimilies, reconstructed from originals, of maps which have been important in the historical development of the country.

The Greyhound Corporation copyrighted in 1953 a map in two parts entitled *Population Centers of the U.S.A.* It includes all urban places of 2,000 population and over. "Metropolitan Centers," "Trunk Centers" (focal points for several metropolitan centers), and other cities and towns are indicated with circles or squares of varying sizes proportioned to their population. The map, which is based on 1950 census figures, was designed and prepared by Richard A. Rice and John S. Gallagher, Jr.

Part I, showing the densely populated Northeast section of the country, measures 18 by 13 inches. The remainder of the country is covered on Part II, which is on a slightly smaller scale. This sheet measures 31½ by 43 inches. The map is uncolored and has no scale given.

The Bureau of the Census, U. S. Department of Commerce, recently released two maps related to our water resources. The first is a *Map of the United States Showing Location of Drained Agricultural Lands: 1950.* The Mississippi River Valley and portions of the Atlantic and Gulf Coastal Plain have the greatest extent of land in drainage enterprises, which are colored red on the map. Red dots represent drained land in irrigation enterprises in the western part of the country. The map is at the scale of 1: 7,000,000 and measures 18 by 28 inches. It was printed in 1952 by the U. S. Government Printing Office, and is available, at 30 cents per copy, from the Superintendent of Documents, Washington 25, D. C.

The second map shows *Location of Irrigated Land, 1949, 17 Western States and Arkansas, Louisiana, and Florida.* Boundaries of major, sub-major, independent, and tributary drainage basins are outlined in red. Green dots of two sizes (500 A. and 1,000 A.) show acreages of irrigated land. A table gives acres irrigated for each of the drainage basins. The map measures 35 by 42 inches and is at the scale of 1: 3,500,000. Copies, at 35 cents each, may be obtained from the Superintendent of Documents.

A *Soil Map of Michigan* at the scale of 1:750,000 was published in 1953 by the Michigan State College Press, East Lansing, Mich. Some 55 different soil types are identified by colors and numbers keyed to a descriptive legend. The map, which was compiled by J. O. Veatch, measures 52 by 40 inches. The base is from the U. S. Geological Survey.

The Pittsburgh Market Map of Allegheny

County was published in 1953 by the Research Department of the Pittsburgh Press. Different colored dots identify areas having "Highest Families," "High-Middle," "Low-Middle," and "Lowest" economic quarters of the families, based on average monthly rents. Census statistics for 1950 were used. Each dot represents 100 families. The names of neighborhoods and unincorporated places in surrounding townships are printed in the color representing their economic quarter. Minor civil divisions and census tracts are outlined in black on the map. The map measures 16 by 20½ inches and is at the scale of 1: 150,000.

Publication of the 1950 Census figures has stimulated the compilation of a number of population maps. The Regional Plan Association, Inc., 205 East 42nd Street, New York 17, has recently published a map of the New York Metropolitan Region showing *Population Distribution—1950*. Dots are used to show distribution, with each dot representing approximately 1,000 persons. The map is at the approximate scale of 1: 540,000 and measures 15½ by 21½ inches.

Population Changes in Chicago, 1940 to 1950, are shown on a map recently issued by the Chicago Plan Commission as one of a series. Other maps of this series show *Industrial Land Use in Chicago, 1950*, and *Growth of Original Residential Settlement in Chicago*. Each map measures 11 by 8½ inches and is drawn to the scale of 1: 200,000.

Official Map, Chicago Terminal District shows the intricate rail network, switching yards, and terminals of Chicago and vicinity. It was copyrighted in 1950 by R. G. Raasch (deposited in 1953) and issued under the supervision of the Chicago Switching Committee, Illinois Freight Association, Union Station, Chicago. The main map measures 40 by 37 inches and is at the approximate scale of 1: 65,000. An enlarged inset map of the downtown Chicago area is at the scale of 1: 9,500.

The Delaware River Port Authority (Camden 2, New Jersey) copyrighted in 1952 a *Map of Delaware River Port Area Showing Facilities in Philadelphia, Camden, Gloucester, Chester, Marcus Hook, Paulsboro, Wilmington, Trenton*. It shows limits of the Port Authority District, railroad lines, yards, stations and float bridges, state and county boundaries, Federal and State highways, and channel depths. The Philadelphia-Camden-Gloucester area is shown on an enlarged inset map. Other insets are "District Map of Delaware River Port Authority," and a map showing "Through Rail and Truck Routes to Philadelphia and Delaware River Port Area." The main map measures 33 by 43 inches and is at the approximate scale of one inch to the mile.

Puerto Rico E Isles Limitrofes is the title of a new map published in 1952 by the U. S. Geological Survey for the Commonwealth Government. The map, which shows the lesser islands under the Puerto Rican Government in their proper position, is available in two editions—one showing topography by means of contours, at 75 cents; and the second with shaded relief, at $1 per copy. Copies may be ordered from the Geological Survey, Washington, D. C., or from the Commissioner, Department of Public Works, San Juan, Puerto Rico.

Both maps are at the scale of 1 :240,000 and measure approximately 20 by 52 inches. In addition to relief, the maps show internal administrative boundaries, roads, railroads, airports, and inhabited settlements.

Plano General del Control Fundamental Para el Mapa Geodesico de Cuba shows the geodetic network of Cuba. The map is a blue-line print at the scale of 1 :500,000. It measures 40 by 94 inches. Data for the map is from the Instituto Cartografico Nacional.

The Canadian Department of Mines and Technical Surveys has issued a new (1953) edition of its popular map entitled *Canada, Principal Mining Areas and Producing Mines*. It is at the scale of 1 :7,603,200 and measures 29 by 34 inches. An "Index to Principal Productive Mines (with names of operating companies)" fills marginal space on the map sheet. Seven small inset maps of Canada show producing areas for selected minerals. Tables and graphs give value of mineral production for 1951, and for the period 1939 to 1951, for the country as a whole, and value of mineral production by provinces for 1951.

The Engineer, United States Forces in Austria, published in 1952 a relief map of Austria at the scale of 1 :500,000. The map, which is accompanied by a comprehensive index of place names, was copyrighted by Bundesamt für Eich- und Vermessungswesen, (Landesaufnahme), Wien, Austria. Internal and external boundaries, roads (of several classifications), highways, cities, towns, and villages, and various other cultural features are shown. The size of the map is 29½ by 37½ inches.

Italie Carte Economique is "Carte N° 56" in the series being issued by Direction de la Documentation, Secretariat Général du Gouvernement (France). It was printed in 1951 at the Institut Geographique National. At the scale of 1 :1,500,000, the map shows, by symbols and over-printed name designations, distribution of various agricultural productions, minerals, industries, power resources, and other economic activities. The map measures 31 by 26 inches. A small inset map shows density of population for Italy.

The railroad network of Spain (*Red de los Ferrocarriles Españoles*) is traced on a large

(1: 600,000 scale) map recently published by the [Spanish] Ministerio de Obras Publicas. Narrow- and standard-gauge lines, completed and under construction, are shown by different symbols. Provincial boundaries and capitals, and centers of judicial districts are given. Enlarged inset maps show the rail systems around the larger cities. The map is printed on four sheets each measuring 33 by 40 inches.

A topographic map of *Grönland* (Greenland) was published in 1951 by the [Danish] Geodaetisk Institut and Dr. Finn Salomonsen. It was prepared to accompany Dr. Salomonsen's book "Grönlands Fugle" (The Birds of Greenland), published by Ejnar Munksgaard, Ltd. The map, which is at the scale of 1 :5,000,000, shows high-arctic, low-arctic, and sub-arctic regions as well as submarine contours, settlements, mines, radio and meteorological stations, and district boundaries. It measures 23½ by 16 inches.

The new administrative and political boundaries of *India, Pakistan, Ceylon & Burma* are delimited on a map published in 1951 by W. & A. K. Johnson, Ltd., Edinburgh and London. Different colors on the map identify the Union of India, States of India (under control of a Rajpramukh and Council of State), States of India (under control of a Commissioner), Pakistan, States within Pakistan, Ceylon, and Burma. A number of cities and towns are located, and major railroad lines are shown. The map measures 26½ by 33 inches and the scale is 1 :4,752,-000.

L'Institut Geographique Nationale (France) published in 1951 an economic map of India entitled *Subcontinent Indien Carte Economique*. It constitutes Map No. 57 of a series being prepared by the Direction de la Documentation, Secrétariat Géneral du Gouvernement (France). Colors and symbols are used to locate industries, mineral deposits, forest areas, and regions of production for the major crops. Major rail lines, dams, and water control project areas are also shown. The map is at the scale of 1 :4,500,000 and measures 26½ by 32 inches.

Some months ago a physical map of North Island, New Zealand, was described here. We are pleased to report now the publication in March 1952 of the corresponding map for *South Island* by the New Zealand Lands and Survey Department. The map is at the scale of 1: 1,000,-000 with relief indicated by graded hypsometric tints and contour lines. Railroads, roads, and inhabited settlements of various sizes are mapped. The map measures 37 by 31 inches.

The Keystone Automobile Club of Philadelphia has recently issued a new *Road Map of Baltimore, Washington and Vicinity*. It was compiled and drafted by O. E. Kline, and lithographed by A. Hoen & Co. Centered on the Washington-Baltimore area, the map extends north to include Lancaster, York, and Shippensburg, Pa. Western limits include Martinsburg and Charlestown, W. Va., and Culpeper, Va. It extends beyond Fredericksburg, Va., and Patuxent (Md.) Naval Air Station on the south. Major roads are shown in red with less-traveled routes in black. The map is at the approximate scale of 3½ miles to an inch and measures 36 by 34 inches. An index of places and enlarged maps of Baltimore and Washington are on the verso. Distribution of Keystone Automobile Club maps is ordinarily limited to club members. ACSM members may, however, obtain copies (as long as available) upon request to O. E. Kline, 220 South Broad St., Philadelphia 2, Pa.

Map of the Treasure Seas is the title of a colorful facsimile of a late sixteenth century map recently published by the Lakeside Press, R. R. Donnelley & Sons Company, 350 East Twenty-second Street, Chicago 16. The facsimile is based on an original, drawn by the Italian cartographer Baptiste Boazio, now in the Ayer Collection of the Newberry Library. The map is centered on the Atlantic Ocean and includes portions of Europe, Africa, and the American continents. The route of one of the voyages of Sir Francis Drake is traced on the map. Printed on the inside of a folder, the map measures approximately 16 by 21 inches. Facing the map is a page of descriptive text about Sir Francis Drake, the map, its cartographer, and the technique used to reproduce it.

—WALTER W. RISTOW

Photogrammetry Courses to be Offered at Trinity

Trinity University in San Antonio, Tex., has announced the introduction of a series of photogrammetry courses, beginning this fall. Initially the courses will include studies in trigonometry, surveying, and elementary photogrammetry and will be expanded later to include advanced work in these subjects.

The courses will be conducted in cooperation with Jack Ammann Photogrammetric Engineers and all laboratory work will be done at the company's plant.

Registration for the courses will begin September 14.

Books in Review

THE LOOK OF MAPS. Dr. Arthur H. Robinson. *University of Wisconsin Press,* Madison, Wis. 1952. 105 pages. $2.75.

The Look of Maps is a most comprehensive delineation of the myriad factors that may be employed in varying degrees and in countless combinations to produce the visual device generally called a map.

This 105-page volume, actually the author's Ph.D. dissertation, might well be likened to the attempt of a swimming coach to teach swimming without getting his student into the water. No matter how thorough the exposition on such matters as the water's specific gravity, salinity, or temperature; the retarding effect of water turbulence on immerged bodies; the merits of the crawl as opposed to the breast stroke; the student will never learn to swim until he plunges into the pool and has a go at the real thing.

And so it is with *The Look of Maps;* it just doesn't get into the water of practical, everyday mapping problems. But when it comes to theorizing on the functions of lettering, design, and color, the author need bow to no one; he rings the bell with a resounding BONG!

Arthur H. Robinson's is the broad, all-inclusive view, the view which is too seldom glimpsed by many of us who are tied to specialized phases of mapping. *The Look of Maps* is *must* reading for those who, lost in the deep, deep forest of cartography, cannot see the woods for the trees.

NEWMAN BUMSTEAD

National Geographic Society

THE PRINCIPLES AND PRACTICE OF SURVEYING, VOLUME II, HIGHER SURVEYING (Seventh Edition). Breed and Hosmer. *John Wiley & Sons, Inc.,* New York. 1953. $7.00.

For almost half a century *Higher Surveying* by Breed and Hosmer has maintained its position as one of the finest available texts on advanced surveying. It is well known for its exceptional clarity, brevity, and its full coverage of the subject. The seventh edition is no exception to this rule. In general it contains most of the text used in the sixth edition with material added to conform with advances in surveying practice.

Under "Astronomical Observations," the modern method of computing the local hour angle is introduced. This includes the use of the Greenwich hour angle of the vernal equinox, the sidereal hour angle of the celestial body, and hence the Greenwich hour angle of the body—all expressed in degrees of arc. Examples have been brought up to date and sun observations in the southern hemisphere are included.

The section on barometric leveling now includes thorough descriptions of the Paulin System altimeter and the Wallace & Tiernan altimeter—both modern precise instruments. The "leap-frog" and the "two-base" methods are described. More emphasis could have been given to the fundamental principle of automatic determination of the air density at each observation, on which the high accuracy of the two-base method depends.

Part III, which is devoted to photogrammetry, contains the most extensive revisions. Although the text states (quite correctly) "Aerial photogrammetry has almost completely superseded ground photography," the unusually good coverage of ground photogrammetry given in the sixth edition is retained. This is fortunate, as the great advantages of ground photogrammetry are beginning to bring the method into more general use today.

The chapters on aerial photogrammetry and stereophotogrammetry contain too many revisions to be listed. The newest cameras and the newest plotters are now included; in general the newest trends, such as the use of Shoran, are covered in these chapters.

The subject of hydrographic surveying has been revised and now includes the newest electronic developments. Manning's formula is introduced under the heading of "Measurements of the Flow of Water" and certain paragraphs have been added to the material on cartography.

The seventh edition is the very-high-quality sixth edition revised to include the new developments that have come into general use in the five years since the sixth edition was published.

PHILIP KISSAM

Princeton University

SURVEYING: THEORY AND PRACTICE. Fourth edition. Raymond E. Davis and Francis S. Foote. *McGraw-Hill Book Company, Inc.,* 330 W. 42nd St., New York

36, N. Y. 1953. 1,021 pages. $8.00

The fourth edition of this extremely practical text has been revised and expanded to continue and improve its logical and comprehensive coverage of the subject. Although prepared primarily as an instruction text, with office and field problems for the student, practicing engineers should find it extremely helpful. The text is well illustrated, and contains the usual mathematical and surveying tables. Each chapter ends with an up-to-date list of references.

Among the noteworthy changes from the third edition are:

The chapter on errors is rewritten to clarify the use of weighted observations in simple and usable form for engineering work, with examples.

Throughout the text, emphasis is placed on the distinction between "precision" and "accuracy" of observations.

Summary tables of errors in chaining and errors in levelling are given.

To clarify the adjustments of the level and the transit, line diagrams show the desired relations between principal lines of the instruments. Alternative methods of the two-peg test are given.

The text on adjustment of compass traverses is expanded to explain the adjustment for both local attraction and errors of observation.

Index error of the transit is redefined to include the effect of three sources of error, which are illustrated with line diagrams.

Strength of triangulation figure is discussed in greater detail, with tabular data and examples.

The chapters on field astronomy are brought up to date and simplified, and the general tables are extended to the year 1960.

The chapter on photogrammetric surveying is entirely rewritten by Col. B. B. Talley, and latest types of instruments are shown and described.

The discussion of errors is unusually good. One chapter is devoted to sources and kinds of errors, observations of equal and different reliabilities, and adjustment of weighted observations. In other chapters, the results of and remedies for mistakes and errors are considered as they apply to specific instruments and procedures.

The chapter on photogrammetric surveying is well prepared and well illustrated. It includes the theory, capability, and uses of most of the photogrammetric plotting instruments that are in use today. Photogrammetry is clearly and logically explained in language intended for the student and the engineer who is not a professional photogrammetrist. Perhaps undue emphasis is given to the obsolescent Brock-Weymouth method as compared to the relatively widely-used multiplex and Kelsh systems.

All major types of field surveys are covered, with ample attention to instruments, methods of operation, short-cuts, and precautions. The office procedures that follow field work are explained, to show the reader the relationship between good field practice and the resulting map, plan, or other product.

The information on the planetable is, perhaps, not as current as it might be. The chief users of the planetable and telescopic alidade are the Federal map-making agencies; it is regrettable that the authors did not devote more space to the method and procedures used by those agencies. However, this deficiency is common to practically all general surveying textbooks. One of the best current treatises on the planetable is *Plane Table Mapping* by Julian W. Low, Harper & Brother, New York, 1952, which is not shown as a reference.

The new and rewritten chapters of the fourth edition make this a notable addition to the literature of the profession. The authors are to be complimented for an excellent job; the purchaser of this book will be making a wise and profitable investment.

C. S. MALTBY

U. S. Geological Survey

A SELECTED BIBLIOGRAPHY OF SOUTHERN CALIFORNIA MAPS. Edward L. Chapin, Jr., with a foreword by Clifford H. McFadden. *University of California Press,* Berkeley and Los Angeles. 1953. 124 pages, offset reproduction. $3.00.

This volume lists 624 southern California maps "covering as many of the important subject fields as possible." It was compiled to "make the great variety of maps [of this area] available to persons in need of them." Forty percent of the items included are unpublished. These maps can, however, be consulted in the offices or depositories listed for each.

The selection for listing was made after examination of more than 1,500 maps. Criteria upon which the choice was made include areal coverage, subject matter, usefulness, and date.

Research investigators in many fields will no doubt find the list of great value in calling to their attention cartographic materials which

might otherwise be unknown to them.

Map users in other parts of the United States would benefit from similar compilations of regional maps. It is hoped, therefore, that Mr. Chapin's example will be emulated by other students of carto-bibliography.

WALTER W. RISTOW
The Library of Congress

New Book on Volcanic Landscapes

A REVISED edition of C. A. Cotton's "Volcanoes as Landscape Forms" was published in June.[1]

Chiefly concerned with geomorphic development, Cotton provides a world-wide survey of superficial volcanic phenomena, and deals with them as they affect the construction and modification of landscape forms. He introduces his subject with a study of the mechanism of volcanism in which he describes types of eruption, lava and pumice volcanoes, volcanic heat from gas reactions, and Vesuvius and its cycle of activity.

The major portion of the book is devoted to volcanic landscapes. Emphasizing the Davisian approach, the author explains how the normal cycle of erosion may be diverted in many ways. His study of these varying factors covers domes and cones of basaltic lava, lava plateaux, plains and fields, and block lava, viscid lavas, ash showers, and ash-built and stratified cones. Among the other volcanic features with which Cotton deals are maars and tuft rings, meteor craters, submarine eruptions and pillow lavas, craters and calderas, depressions and lakes, basalt plateaux and plains, and the erosion and destruction of volcanic mountains.

The author is professor of geology at Victoria University College in Wellington, New Zealand. In this revised edition he has not only added up-to-date information to the text, but has included previously unavailable photographs, including oblique aerial photos.

"Volcanoes as Landscape Forms" contains 416 pages and is priced at $9.00.

[1] *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y.

"Dynamical Oceanography"

A NEW BOOK entitled "Dynamical Oceanography," by Dr. J. Proudman, Professor of Oceanography at the University of Liverpool, was published in June.[1] The book, which deals with the nature and causes of the great ocean currents, tides, waves, and seiches, represents the first systematic treatment of the subject to appear in the English language.

Dr. Proudman first deals with general principles and with certain simple types of currents, including an exposition of the technique used extensively to compute the magnitude of ocean currents from observations of temperature and salinity made on oceanographic expeditions. A discussion of the turbulence of the sea and the important consequences relating to internal friction and the mixing of sea water is followed by a study of the thermodynamic circulations of an ocean. The subject of tides, extensively treated, is followed by an analysis of waves produced by wind, and internal oscillations of short period.

Characterizing his book as a deductive treatise, Proudman says: "Starting from the fundamental principles of dynamics and of thermodynamics, with the physical properties of sea water, and assuming also the conditions which arise outside the ocean, deductions are made relating to the movements of the waters of the oceans." He goes on to explain the main structure of his book as one of simple mathematical argument, in which the operations employed do not extend beyond elementary differentiation and integration. Use is also made of alternative arguments involving only qualitative reasoning.

"Dynamical Oceanography" contains 409 pages and is priced at $8.50.

[1] *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession.

—EDITOR

Topographic Maps

THE FOLLOWING quadrangle maps were published by the U. S. Geological Survey between March 1 and May 31, 1953. All maps are available with or without green overprint which indicates woodland. The quadrangle name is shown in capital letters, followed by the county name in upper- and lower-case letters. Since many quadrangle maps extend into several counties, only that county name is given which contains the place for which the quadrangle is named. For example, the quadrangle BEN LOMOND, in *California,* is in parts of Santa Clara, Santa Cruz, and San Mateo counties, but only Santa Cruz is shown because the village of Ben Lomond is in that county.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo.

Alaska

CRAIG (C-4)*—First Judicial Division†
CRAIG (D-1)*—First Judicial Division†
CRAIG (D-4)*—First Judicial Division†
JUNEAU (B-1)*—First Judicial Division†

Arizona

ELGIN*—Santa Cruz

Arizona-California

MULE WASH—Yuma

California

ALDER PEAK—Monterey†
BEAR CANYON—Monterey†
BEN LOMOND*—Santa Cruz
BIG BEND MOUNTAIN*—Butte
BLOSSOM—Tehama†
BLUE LAKE*—Humboldt†
BLUE NOSE MOUNTAIN—Plumas
BRANSCOMB*—Mendocino†
CAPE SAN MARTIN—Monterey†
COULTERVILLE*—Mariposa†
DOWNIEVILLE—Sierra†
FERNDALE*—Humboldt†
HAMES VALLEY—Monterey†
HOLT—San Joaquin
ISLETON—Sacramento
JUNIPERO SERRA PEAK—Monterey†
LAKE PILLSBURY*—Lake
LAKEPORT*—Lake
LAYTONVILLE*—Mendocino†
PEDDLER HILL—El Dorado
PLACERVILLE*—El Dorado
REDONDO BEACH—Los Angeles†
SIDEWINDER WELL*—Los Angeles†
SONORA*—Tuolumne
TRANQUILLITY*—Fresno†
WILLIAMS HILL—Monterey†

California-Oregon

GASQUET*—Del Norte

Colorado

ATWOOD—Logan†
BRUSH EAST—Morgan†
JUDSON HILLS—Morgan†
MANILA—Adams†
MERINO—Logan
PADRONI—Logan†
PADRONI NW—Logan†

Connecticut

BETHEL—Fairfield†

Florida

ALFORD—Jackson
ALTHA EAST—Calhoun
COTTONDALE EAST—Jackson†
COTTONDALE WEST—Jackson
CYPRESS—Jackson†
DELLWOOD—Jackson†
HOMELAND—Polk†
KYNESVILLE—Jackson†
LAKE ARBUCKLE—Polk
LAKE ARBUCKLE SE—Highlands†
LAKE WALES—Polk†
LORIDA—Highlands†
OAKDALE—Jackson†

Georgia

FORSYTH*—Monroe

Idaho

MENAN BUTTES—Madison
PLANO—Madison

Idaho-Oregon

PAYETTE—Payette

Indiana

CLINTON FALLS—Putnam†
DUGGER—Sullivan†
GREENFIELD—Hancock†
INGALLS—Madison
ODON—Daviess
SHELBURN—Sullivan†

Indiana-Illinois

HUTTON—Vigo

Kentucky

AUBURN—Logan
BURTONVILLE—Lewis
CLINTON—Hickman†
DENNIS—Logan†
EUBANK—Pulaski
HAZEL GREEN—Wolfe
HUSTONVILLE—Lincoln
LANCASTER—Garrard

* Indicates 15-minute quadrangle; all others and 7½-minute quadrangles.
† Indicates map lies wholly within county named.
‡ Indicates availability in either a contour or a shaded-relief edition.

LANDSAW—Wolfe
LENOX—Morgan
ROCKFIELD—Warren
SALYERSVILLE SOUTH—Magoffin
STANFORD—Lincoln
WHITE OAK—Morgan

Kentucky-Indiana
OWENSBORO WEST—Daviess
REED—Henderson

Kentucky-Missouri
WICKLIFFE—Ballard

Kentucky-Missouri-Tennessee
HICKMAN—Fulton
HUBBARD LAKE—New Madrid

Louisiana
LULING—St. Charles
PONCHATOULA*—Tangipahoa

Maine
BETHEL*—Oxford†
MILLINOCKET*—Penobscot

Maryland
ANNAPOLIS—Anne Arundel

Maryland-Delaware
CECILTON—Cecil
DELMAR—Wicomico

Maryland-Pennsylvania
NEW FREEDOM—York
NORRISVILLE—Harford

Maryland-Virginia
BLAKISTON ISLAND—St. Marys
BOXIRON—Worcester
CRISFIELD—Somerset
PINEY POINT—St. Marys
POCOMOKE CITY—Worcester
POINT OF ROCKS—Frederick
WHITTINGTON POINT — Worcester

Maryland-Virginia-Pennsylvania
CHERRY RUN—Morgan

Massachusetts
ASSONET—Bristol
NORTON—Bristol

Massachusetts-New Hampshire
LOWELL—Essex

Michigan
COTE DAME MARIE—Crawford
FLETCHER—Kalkaska
HASTINGS*—Barry†
LAKE MARGRETHE—Crawford

Minnesota
ABBOTT—St. Louis†
ANNANDALE*—Wright
BRITT—St. Louis†
INVER GROVE—Dakota
ROTHSAY*—Wilkin
ST. PAUL SW—Dakota

Minnesota-Wisconsin
LAKE CITY*—Wabasha

Mississippi-Tennessee
WALNUT*—Tippah

Missouri
MANSFIELD—Wright
MANSFIELD NE—Wright†
MANSFIELD NW—Wright

Missouri-Kentucky
NEW MADRID SE—Fulton

Montana
ANCENEY*—Madison
BLACK BUTTE MOUNTAIN — Meagher†
CARNEY—Sweet Grass†
CLIFF LAKE*—Madison†
HAMEN—Meagher†
HATFIELD MOUNTAIN—Gallatin†
MANHATTAN*—Gallatin
McLEOD BASIN—Sweet Grass
RASPBERRY BUTTE—Sweet Grass†
RINGLING—Meagher
WALLROCK—Gallatin
WOLF HILL—Meagher

Nebraska
ANSELMO NW—Custer
ARCADIA EAST—Valley
ARCADIA SE—Sherman†
CALLAWAY—Custer†
EDDYVILLE NE—Custer†
EDDYVILLE NW—Custer†
LITCHFIELD—Sherman
LITCHFIELD NE—Sherman†
MASON CITY—Custer†
MASON CITY NW—Custer†
MASON CITY SE—Custer
MASON CITY SW—Custer
MILBURN—Custer
OCONTO NW—Custer†
RICHFIELD SW—Sherman
ROUND VALLEY—Custer†
WALWORTH—Custer

Nevada
ALLEN SPRING*—Churchill
CARSON SINK*—Churchill†
FALLON*—Churchill
SODA LAKE*—Churchill†

Nevada-California
ASH MEADOWS*—Nye

New Jersey-Pennsylvania
BELVIDERE—Warren
FRENCHTOWN—Hunterdon

New Mexico
BECKER SW—Socorro†
BELEN NW—Valencia†
BELEN SW—Socorro
BLACK BUTTE—Socorro
CONNOR WELL—Chaves†
NINEMILE WELL—Chaves†

New York
AUBURN—Cayuga†
WESTDALE—Oneida

New York-Connecticut
POUND RIDGE—Westchester

New York-New Jersey
UNIONVILLE—Orange

New York-New Jersey-Pennsylvania
PORT JERVIS SOUTH—Orange

North Carolina
BELHAVEN—Beaufort
EDWARD—Beaufort
ENGELHARD WEST—Hyde†
FAIRFIELD—Hyde
McLEANSVILLE—Guilford†
NEW HOLLAND—Hyde
OXFORD*—Granville
PAMLICO BEACH—Beaufort
PANTEGO—Beaufort†
PONZER—Hyde

North Carolina-South Carolina
PIREWAY—Columbia

North Dakota
HAMBURG—Wells
JOSEPHINE—Benson†
MADDOCK—Benson†
PEKIN—Nelson†
PINGREE—Stutsman†
TOLNA—Nelson†

Ohio
COLUMBIANA—Columbiana
YOUNGSTOWN—Mahoning†

Ohio-Pennsylvania
CAMPBELL—Mahoning
NEW MIDDLETON—Mahoning

Oklahoma
ARBUCKLE HILL—Comanche†
ELGIN—Comanche
QUANAH MOUNTAIN—Comanche†

Oregon
DALE*—Grant

Oregon-Idaho
WEISER SOUTH—Washington

Pennsylvania
DRIFTWOOD*—Cameron
GETTYSBURG—Adams†
LANSDALE—Montgomery†
POTTSVILLE‡—Schuylkill†

Pennsylvania-New Jersey
BANGOR—Northampton
RIEGELSVILLE—Bucks
STROUDSBURG—Monroe

Puerto Rico
COAMO—Coamo
PUNTA VERRACO—Yauco
RIO DESCALABRADO—Santa Isabel
SALINAS—Salinas
SANTA ISABEL—Santa Isabel

South Carolina-North Carolina
LITTLE RIVER—Horry
LONGS—Horry

South Dakota
CAPA—Jones†
CAPA SE—Jones†
DUPREE NE—Ziebach
IMOGENE—Perkins†
MAURINE—Meade
MURDO SE—Jones
OKATON SE—Jones
PROMISE—Dewey†
ROCKYFORD NW—Shannon†
ROCKYFORD SE—Shannon†
ROCKYFORD SW—Shannon†
SMITHWICK NW—Fall River
THUNDER BUTTE—Zeibach
VALE—Butte
VALE SE—Meade
VOLUNTEER—Meade

Tennessee
BUENA VISTA—Carroll†
CLARKSVILLE—Montgomery†
DANIELS LANDING—Berry
HALLS CREEK—Humphreys
HURRICANE MILLS—Humphreys
HUSTBURG—Humphreys
INDIAN MOUND—Stewart
LACONIA—Fayette†
MILAN—Gibson†
PALMER SHELTER—Carroll†
ROCKPORT—Benton
SEVENTEEN CREEK—Benton
SUGAR TREE—Decatur
THARPE—Stewart†
WAVERLY—Humphreys†
WOODLAWN—Montgomery

Texas
ALLYNS BIGHT—Aransas
BAY CITY NE—Matagorda
DRESSING POINT—Matagorda†
FRANCITAS—Jackson
FRANCITAS NW—Jackson†
GREEN ISLAND—Willacy
IRA NW—Borden
KLEBERG POINT—Kleberg
LAKE AUSTIN—Matagorda†
MIDFIELD—Matagorda
NORTH OF PORT ISABEL NW—Willacy
PALACIOS—Matagorda†
PALACIOS POINT—Matagorda†
PALACIOS SE—Matagorda†
POTRERO LOPENO SE—Kenedy†
RIVIERA BEACH NW—Kleberg†
SOUTH BIRD ISLAND NW—Kleberg†
SOUTH OF PALACIOS POINT—Matagorda†

SOUTH OF POTRERO LOPENO NW—Kenedy†
SOUTH OF POTRERO LOPENO SE—Willacy

Utah

OAK CITY*—Millard†
SALT LAKE CITY NORTH—Salt Lake

Virginia

COBHAM BAY—Surry

Virginia-Maryland

HALLWOOD—Accomack
HEATHSVILLE — Northumberland
SUNNYBANK—Northumberland
WAKEFIELD—Westmoreland
WIDEWATER—Stafford

Washington

DECEPTION PASS*—Island

West Virginia-Virginia-Maryland

CHARLES TOWN—Jefferson
HARPERS FERRY—Jefferson

Wisconsin

BARRON*—Barron†
CORNELL*—Chippewa†
GILMAN*—Taylor

Wyoming

ARGO BUTTE—Fremont†
BONNEVILLE—Fremont†
BULL LAKE EAST—Fremont†
DEWEY SW—Weston
DUTCH NICK FLAT NW — Big Horn
EAGLES NEST—Platte
FORT RIDGE—Natrona
INDEPENDENCE ROCK — Natrona
INDIAN BUTTE—Fremont†
JENKINS MOUNTAIN — Fremont†
LOOKOUT BUTTE—Fremont†
MAVERICK SPRING—Fremont†
MEXICAN PASS—Hot Springs
MORRISEY NE—Weston†
MOBRISON CANYON—Fremont
MORTON—Fremont†
NEWCASTLE—Weston†
OSAGE SE—Weston†
OWENS—Weston†
RIVERTON WEST—Fremont†
SCHUSTER FLATS SE—Washakie†
SHOSHONI—Fremont†
TATMAN MOUNTAIN — Big Horn

Wyoming-South Dakota

CLIFTON—Weston

In addition to the standard series of quadrangle maps, reconnaissance maps at the scale of 1:250,000 are being published for both the continental United States and Alaska. The map in this series published for the period is:

Alaska

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News of Related Organizations

Milwaukee Land Surveyors Organize

The land surveyors in Milwaukee have taken initial steps to form a society. They held an organization meeting in March and at that time decided to investigate the possibilities of association with the Wisconsin Society of Land Surveyors. Dick Mecha, Bob Hall, and Red Wagner represented WSLS at the Milwaukee Meeting and received an enthusiastic reception. As a result of this visit, thirteen new members were obtained for WSLS. While the number itself is impressive, the most important aspect is the enthusiasm of this new group.

Wisconsin Registration Bill Fails to Pass

Despite the strong backing of the Wisconsin Society of Land Surveyors, a bill providing for registration of land surveyors in the State of Wisconsin was shelved by the Legislature and will probably not be considered again until 1955.

In spite of this setback, the WSLS is drafting a new surveyor registration law and a new county surveyor law and is taking steps to protect the provisions of the existing platting law.

The society now includes 116 active members and 4 affiliate members.

WSLS is informed by the Director of Regional Planning that a plat was recently submitted to him for approval showing curves used in laying out streets as portions of a parabola instead of the usual practice of showing the curves as arcs of a circle. In his comment on this plat the Director of Regional Planning pointed out that the statutes plainly contemplate that the curves used shall be portions of the circle and that there is no good reason why any other kind of curve should be used. Curves other than circular curves, he pointed out, provide no advantages from the standpoint of operation of vehicles and are much more difficult to trace.

Virginia Association of Surveyors

The Northern Virginia Chapter of the Virginia Association of Surveyors, Inc., whose constitution stipulates membership in ACSM as a condition to Chapter membership, has been making good progress this year. An association windshield decal has been issued to the membership, which now numbers 29. The chapter will have a listing in the new Virginia telephone book due in September.

VICTOR H. GHENT

Georgia Land Surveyors Meet

The annual meeting of the Georgia Association of Registered Land Surveyors was held in June at the King and Prince Hotel on St. Simons Island, Ga. In an election held at the meeting, J. R. Bracewell of Atlanta was elected President of the Association for the fiscal year ending June 30, 1954. Other officers elected include R. M. Marbury, Jr., Vice President, and H. O. Robison, Secretary-Treasurer.

The 24 members in attendance, together with their wives and guests, enjoyed tours planned jointly with the Georgia Society of Professional Engineers, holding its annual meeting simultaneously at the same hotel.

A monthly meeting was held in July at the home of Director John F. Carey at Cornelia, Ga., where some 27 members and guests enjoyed a barbeque dinner and witnessed demonstrations of new types of surveying instruments, including an ultra-high-frequency, two-way portable radio used for directing the work of survey parties.

H. O. Robison
Secretary-Treasurer

"TECHNICAL ILLUSTRATION"

A new illustrated book on the subject of three-dimensional drawing has been published by a nationally-known drafting products company[1] as a service to engineers and draftsmen. The book, entitled *Technical Illustration,* is planned to fill a widespread current need for material on an art which is all but ignored in the field of engineering education—the preparation of perspective and axonometric drawings which may be dimensioned and which are sound from the engineering standpoint. This art, it is claimed, is in ever-increasing demand by industry.

The book contains 22 illustrative plates and is 8½ by 11 inches in size. It is priced at $2.50 per copy, and may be obtained directly from the drafting products company.

[1] Higgins Ink Co., Inc., 271 9th St., New York, N. Y.

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CONGRESS NEWS

Election of Officers for 1954

As previously announced (January–March 1953 issue of SURVEYING AND MAPPING, page 110), the annual nomination and election of officers was postponed and the balloting for 1954 officers will take place in the last quarter of 1953.

ACSM is pleased to introduce the following candidates presented by its official Nominating Committee consisting of Marshall S. Wright, Chairman; Helmuth Bay; and Franklin G. Williams:

For President (one-year term):
CARROLL F. MERRIAM
For Vice President (one-year term):
WILLIAM C. WATTLES
For Directors, 1954–55 (Five to be elected for two-year terms):
GORDON E. AINSWORTH
CHARLES H. ANDREGG
BENJAMIN EVERETT BEAVIN, SR.
CHARLES F. FUECHSEL
GEORGE J. PARRISH
ROBERT H. RANDALL, JR.
PAUL P. RICE
ARTHUR J. SWEET

Brief biographies of the candidates follow:

CARROLL F. MERRIAM

Born in Framingham, Mass., in 1892, Carroll F. Merriam received his SB degree at Harvard in 1914 and his BS degree at Worcester Polytechnic Institute in 1916, following which he served four years as instructor.

He served with the 101st Engineers (26th Division) in World War I.

Since 1924, Mr. Merriam has been an engineer with the Pennsylvania Water and Power Co., Baltimore, Md. He was appointed to a committee set up to prepare legislation for adoption of plane coordinates in Maryland and has since acted unofficially as consultant to the State Advisory Board.

He holds memberships in the American Society of Mechanical Engineers and the American Geophysical Union. He joined ACSM in 1940 shortly after the organization meeting, and in 1952 served as Chairman of the Control Surveys Division.

WILLIAM C. WATTLES

Though a native of Kansas, William C. Wattles has been a resident of California for the past 48 years, and received his EM degree in 1903 at Colorado School of Mines.

He is a Licensed Land Surveyor and Registered Civil Engineer of California, specializing in land and title location. For 10 years he was with the Los Angeles County Surveyor, Flood Control, and Road Department office as Chief of Party, Office Engineer, and Deputy. For 31 years he was associated with the Title Insurance and Trust Co., Los Angeles, as Field Engineer, Title Engineer, and Chief Engineer. He is an author and lecturer on land location, title location, property descriptions, and allied subjects.

Mr. Wattles is a member of the American Right of Way Association. He has been a member of ACSM for 12 years, serving as Chairman of the Technical Standards Committee, Chairman of the Property Surveys Division, member of the Advisory Council, and as a Director.

GORDON E. AINSWORTH

Gordon E. Ainsworth was born in Littleton, N. H., in 1909, attended the local schools, and was graduated from the University of Massachusetts in 1934, having spent one year of undergraduate study at the University of Maine in the interim. His major studies were in the fields of Civil Engineering and Forestry.

Since graduation from college he has specialized in land surveying and general field practice, and since 1941 has maintained an office in Deerfield, Mass., staffed mainly with field personnel operating in the six New England States.

His membership in professional organizations include MSPE, NSPE, and the Society of American Foresters. In ACSM he has been a member of the Publications Committee and Property Surveys Division for the past two years.

CHARLES H. ANDREGG

Charles H. Andregg received his Bachelor of Science degree from Kent State University in 1939 and took additional courses at the University of Louisville and George Washington University. His first professional interest in, and official connection with, topographic mapping was with the Army Map Service Field Area Headquarters at Louisville, Ky., in 1942.

Since 1943 he has been with the Army Map Service in Washington, and now serves as Comptroller and Special Assistant to the Commanding Officer.

BENJAMIN EVERETT BEAVIN, SR.

Benjamin Everett Beavin, Sr., Registered Professional Engineer and Land Surveyor, attended Johns Hopkins University.

He has served as Assistant Chief Engineer, Anne Arundel Sanitary Commission and the Annapolis Metropolitan Sewerage Commission; as a Director, Annapolis Housing Authority; and as Associate with J. E. Greiner Company. A consulting engineer, with particular emphasis on airports, surveying, and mapping, he is now a member of the engineering firm of Porter, Urquhart & Beavin, Baltimore, Md.

Mr. Beavin currently serves ACSM as Vice President and is also active as Chairman of the Division on Control Surveys. Mr. Beavin holds membership in the American Congress on Surveying and Mapping, the American Society of Civil Engineers, the Society of American Military Engineers, the American Water Works Association, the American Road Builders Association, and the Highway Research Board.

CHARLES F. FUECHSEL

A graduate of Pennsylvania State in 1924, Charles F. Fuechsel was Asst. State Forester, Alabama, in 1924–25. He has been a Topographic Engineer with the U. S. Geological Survey since 1925. He spent short periods with Standard Oil Co. of Venezuela and the City of Atlanta. His present assignment is Chief of Cartographic Section, Topographic Division, USGS.

GEORGE J. PARRISH

Born in Powhatan County, Va., July 28, 1898, George J. Parrish graduated from John Marshall High School, Richmond, Va., in 1918; and attended Columbia University, the University of Richmond, and the University of Virginia. He was president-elect of his engineering class.

He was employed by the City of Richmond on Aug. 8, 1921, assisting in the computation and adjustment of triangulation and traverse nets in the geodetic and topographic survey of Richmond, 1921–23. He supervised computation, adjustment, and compilation of maps of the "Old City" section of Richmond during 1923 and 1924, and land subdivision and city planning, 1924–25. He has been Chief, Division of Surveys, Department of Public Works, Richmond, since 1925.

ROBERT H. RANDALL, JR.

Graduating with a BSCE degree in 1941, Robert H. Randall, Jr., participated in surveys of the U. S. and Alaska as a commissioned officer of the Coast and Geodetic Survey, specializing in Shoran surveys after completing Navy radar training at M.I.T. Joining the Hydrographic Office in 1948, he engaged in its Loran and radar charting activities and is now the Chief Engineer's Special Assistant for Research and Development. He is Deputy to the Hydrographer as Navy member on the RDB Committee on Geophysics and Geography and was 1952 Navy Delegate to the VI Consultation on Cartography at Ciudad Trujillo .

PAUL P. RICE

Born in Easton, Pa., on June 27, 1902, Paul P. Rice was educated in Easton Public Schools and Lafayette College, receiving his BS degree in CE in 1929.

His varied experience includes land surveying practice, 1923–27; construction engineering, 1929–30; instructor and assistant professor of civil engineering, Lafayette College, 1931–48; and associate professor of civil engineering, Rutgers University, from 1948 to date. He was the organizer and initial chairman of "Committee VIII, Surveying and Mapping" in the Civil Engineering Division of ASEE that promoted our Congress. He is a licensed Professional Engineer and Land Surveyor in New Jersey; and Executive Secretary, Land Surveyors Division, New Jersey Society of Professional Engineers. He is co-author of "Engineers Field Notes," and author of various magazine articles on surveying subjects. He has been active in technical, professional, and educational organizations promoting surveying since 1926.

ARTHUR J. SWEET

Arthur J. Sweet is a member of the Technical Review Staff, Office of the Secretary, Department of the Interior. He studied engineering

at the University of Michigan and for a number of years was District Engineer for R. H. Randall and Co., geodetic and topographic engineers, doing extensive work in the field of city surveys. In 1937 he was made Director of the Cleveland Regional Geodetic and Topographic Survey. During World War II he was engaged in mapping and terrain intelligence work with the Corps of Engineers and Military Intelligence, G-2. He served as Assistant Chief Examiner on Surveying and Mapping, Bureau of the Budget, until taking his present position.

Cartography and Topography Divisions Joint Meeting

The Technical Division on Cartography held its sixth semi-annual local meeting on June 11, 1953, in the Interior Department Auditorium in Washington. This was the third consecutive local meeting sponsored jointly with the Technical Division on Topography.

The meeting was attended by more than 300 members of the Congress and guests from the Washington area.

Floyd W. Hough, Chief, Geodetic Division, Army Map Service, Corps of Engineers, gave a most interesting talk on the "Current Geodetic and Astronomic Operations on the Arc of the 30th Meridian in Africa." Mr. Hough's presentation was in non-technical style, which clarified the entire subject for many of the audience. The project dealt with the completion of a chain of geodetic control from Scandinavia to South Africa through a final gap in Africa. Mr. Hough explained how, from this work, a new and more accurate determination could be made of the shape of the earth.

A vivid realization of the worth of a good topographic map was afforded by Dr. Walter G. Stoneman's paper on map use, entitled "Help Your Neighbors by Getting Them to Use More Maps." Dr. Stoneman, Deputy Chief, Burma Branch, Technical Cooperation Administration, Department of State, displayed more than 100 books to illustrate effectively the voluminous writings required to describe in words all the information to be gleaned from a single topographic map of Washington, D. C.

The meeting was concluded with the first public showing of a color motion picture prepared by the U. S. Coast and Geodetic Survey, entitled "Activities of the U. S. Coast and Geodetic Survey."

The next local Washington meeting, again to be sponsored by these two Technical Divisions, is tentatively scheduled for early November. Chairmen Moravetz and Griffith, of the Cartography and Topography Divisions respectively, personally invite all members of the Congress who can be in the area at that time to attend.

WILLIAM B. SEARS
Secretary, Cartography Division

Texas Section

The officers and directors of the Texas Section held a joint board and program meeting on July 2, 1953, at the Houston Engineer's Club, with Section Chairman E. D. Morse presiding. The main item of business was to set the time and date for the next Section meeting.

Vice-Chairman R. M. Atkinson pointed out that the Surveyors' Short Course in Austin will probably be held the first week in October and made a motion, which was carried, that the next Section meeting be held on September 25, 1953, in order to avoid interference with the Austin meeting. It was agreed that the meeting would be held at the Houston Light & Power Company's Beatty Station Auditorium.

Treasurer L. P. Carr reported a total mem-

bership of 154, of which 137 have paid 1953 Section dues.

Forrest Daniell, Section Editor, volunteered to contact the University of Houston, Rice Institute, and the Houston Public Library to urge that they subscribe to SURVEYING AND MAPPING.

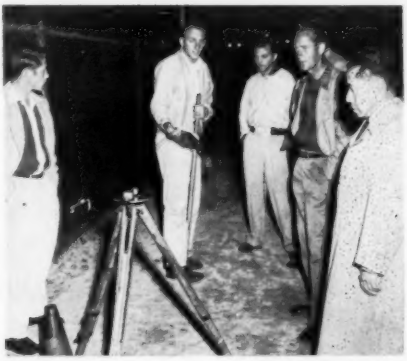
Chairman Morse announced the following as members of the Nominating Committee: O. E. Young, J. C. Lipscomb, and A. B. Zube.

FORREST DANIELL
Section Editor

Southern California Section Demonstrates Night Triangulation

A successful field demonstration was presented by the Southern California Section of ACSM on April 21, 1953, before a record attendance of over 280 members and other interested persons. Los Angeles' famous Griffith Park was the setting for a field program entitled "Triangulation in Action" which was made doubly interesting because it was held at night. A running explanation of the demonstration was given by Alfred Boysen, Survey Supervisor of the Los Angeles Bureau of Engineering. The outdoor program included: precise taping procedure with invar tape; angular measurement by means of a theodolite mounted on a platform, with observations on signal lights atop the Hollywood hills; and inspection of equipment which is regularly used by the city geodetic crews. The demonstration proved to be a valuable example of good engineering in this area.

(Photo by W. H. Watts)
ALBERT COCKING OF THE LOS ANGELES BUREAU OF ENGINEERING GEODETIC CREW DEMONSTRATES NIGHT TRIANGULATION WITH THEODOLITE.



(Photo by W. H. Watts)
SCENE AT ONE END OF INVAR TAPE SHOWING TENSION BEING APPLIED, DURING DEMONSTRATION OF PRECISE TAPING PROCEDURE. THIS PHOTO SHOWS A BIT OF THE RECORD CROWD WHICH ATTENDED THE DEMONSTRATION.

The outdoor program was followed by an exhibition of maps and instruments inside Griffith Auditorium. Mr. Boysen presented a paper on the practical application of coordinates

in the layout of the nearby Three-Mile Outfall Sewer Tunnel.

Henry Thomson, Survey Supervisor of the Bureau of Engineering, gave a comprehensive view of the development of coordinated control monuments in the Los Angeles area. There are 6,000 such monuments in city and county territory at present.

The meeting was planned for the Technical Committee by Cecil Hanson, Chief Surveyor, Los Angeles County Flood Control District, who was ably assisted by Ben O. Badgley, Chief Surveyor, Bureau of Engineering. The value of the ACSM to local members is greatly enhanced by the cooperation of prominent local engineers such as those who worked together for the success of this outstanding program.

On June 2, the Section held its monthly meeting in the General Petroleum Corporation's auditorium. About 100 members were in attendance. A new U. S. Coast and Geodetic Survey motion picture was shown through the courtesy of Roy M. Sylar of the USC&GS. This was pronounced an excellent photographic effort as well as a very instructive film.

Through the courtesy of D. U. Wheaton, Special Representative of the Southern California Gas Co., the spectacular motion picture, "Pipeline Licks the Weather," was also shown. The film shows how some difficult engineering problems were solved. The Big Inch gas line from Texas to California was completed a few short years ago.

Howard R. Saunders, Draftsman with the City, described and exhibited his new Los Angeles County Cadastral Index. The completed series of cadastral maps will fill a need long felt in this rapidly changing area. Mr. Saunders has done up a neat package of maps in a large folio now available for general use.

We are sorry to learn of the retirement from active duty of Comdr. Dan Whelan on June 30, but we expect him to counsel us in future policies of this Section when we resume full activity in late September.

—JOHN E. ASHER
Section Editor

ACSM Provides Maps to the National Boy Scout Jamboree

The Public Relations Committee of the ACSM, in collaboration with the National Capital Area Council, Boy Scouts of America, prepared library kits and posted maps on each of the ten railroad cars of the special train carrying Boy Scouts from the Maryland, Virginia, and Washington, D. C., area to the National Boy Scout Jamboree at Newport Beach, Calif., July 17 to 23, 1953.

The library kits, to which many organizations contributed maps and literature for the enjoyment and education of the Scouts, contained small- and large-scale maps of various kinds, pamphlets and booklets describing and illustrating points of interest along the way, mimeographed articles on maps and mapping, and a complete list of all the maps in the kit showing where each may be obtained.

Among the maps posted on the walls of the train were a small-scale road map, an aeronautical planning chart, a railroad map, a geographic map, and a historical map, each showing all of the United States. In addition, larger scale maps of points of interest were displayed.

It is hoped that, through this means, the Scouts were helped to a greater appreciation of our great land—its vastness and beauty—and that thereby they will become better citizens.

ALFRED C. STIEFEL
Chairman, Public Relations Committee

Personals

The ACSM report on research activities was presented at the annual meeting of the National Research Council, Division of Geology and Geography, by Charles H. Davey, U. S. Geological Survey, on May 2, 1953. Mr. Davey is retiring as ACSM representative to the National Research Council, after three years of service in that post. Capt. H. Arnold Karo, Chief, Divi-

sion of Charts, U. S. Coast & Geodetic Survey, has been nominated to be ACSM representative to the Council for the next three years beginning July 1, 1953.

May 9, 1953, marked the inauguration of G. Brooks Earnest as the third president of Fenn College of Cleveland, Ohio. President Earnest is an active charter member of the American Congress on Surveying and Mapping, and is well known in surveying and mapping circles. He has for the past several years been director of the Cleveland Regional Geodetic Survey. The Congress was represented at the inaugural ceremonies by past-President S. A. Bauer.

Prof. George H. Harding, President of ACSM in 1952, resigned on July 1, 1953, from Ohio State University's Institute of Geodesy, Photogrammetry, and Cartography and from the Mapping and Charting Research Laboratory. Prof. Harding served as Executive Director of the Institute and as Director of the Research Laboratory. Prof. Harding's future plans in his chosen field of developing surveying and mapping education have not yet been announced.

Charles C. Lindsay, Canadian member of ACSM's Advisory Council, was recently made President of the Quebec Corporation of Land Surveyors. Mr. Lindsay is well known to Congress members with affection and esteem.

Howard W. Whitlock has resigned from the Soil Conservation Service of the U. S. Department of Agriculture to accept a position with Jack Ammann Photogrammetric Engineers, San Antonio, Tex. Mr. Whitlock is a former member of the ACSM Publications Committee and has taken an active part in annual meeting programs.

Capt. Earle A. Deily, Supervisor, Southeastern District Headquarters, U. S. Coast and Geodetic Survey, Norfolk, Va., retired on July 31, 1953, after 30 years of service in the Bureau.

During his long years of service with the Coast and Geodetic Survey, Capt. Deily has performed many assignments in hydrographic and geodetic surveying along all coasts of the United States and in the Philippines. His office assignments have included duty in the Washington, New York, Boston, San Francisco, and Seattle offices.

Rear Adm. K. T. Adams, ACSM director and former Chairman of the Publications Committee, has sold his home in Falls Church, Va., and is now living in California.

Marshall S. Wright, a charter member of ACSM and its president for 2½ years during 1947 to 1949, retired from the U. S. Department of Agriculture on June 29, 1953.

During his 36 years of Federal service, Mr. Wright saw service with the General Land Office, the Forest Service, the Soil Conservation Service, and with the Office of the Secretary of Agriculture. Throughout this period he has been engaged in surveying and mapping activities and has actively advanced surveying and mapping as a science and profession through his membership and service in many organizations.

Mr. Wright represented ACSM at the VIII^{e} Congres Internationale des Géomètres held in Paris, France, August 28 through September 6, 1953.

J C Carpenter, active ACSM committeeman, recently retired from the Bureau of Public Roads after 43 years of service. His long career, devoted exclusively to highway engineering, included years of service in the Philippines, Puerto Rico, Texas, and Virginia, before coming to the Washington headquarters where he became an outstanding authority on toll highways.

In the Congress, Mr. Carpenter served as Chairman of the Committee on Highway Surveys in the Control Surveys Division and was instrumental in developing standards for highway surveys which were adopted by the Congress.

Since his retirement, Mr. Carpenter has been associated with Coverdale & Colpitts, Consulting Engineers of New York City.

Capt. Thomas B. Reed, Western District Headquarters, U. S. Coast and Geodetic Survey, San Francisco, Calif., retired on May 30, 1953, after serving for nearly thirty years in the Bureau.

His many field assignments with the Coast and Geodetic Survey have included duty aboard

various survey ships in Alaska, the Hawaiian, Midway, and Aleutian Islands, and along the East, West, and Gulf coasts of the United States. Until recently, he served as Commanding Officer of the USC&GS Ship *Pioneer*. For several years Captain Reed was Chief of the Section of Field Records in the Washington office. From 1947 to 1949 he served as Officer in Charge of the Baltimore Photogrammetric Office.

Among the organizations in which he holds membership are the American Congress on Surveying and Mapping, American Society of Photogrammetry, and Society of American Military Engineers.

❦ ❦ ❦

Notice to All Members

The words "Forwarding and Return Postage Guaranteed" will no longer appear on SURVEYING AND MAPPING second-class mailing envelopes.

Recent changes in postal rules and regulations have abolished the privilege of forwarding second-class mail at second-class transient rates; such forwarding and returning are now classified as fourth-class or parcel post in the case of SURVEYING AND MAPPING which weighs over 8 ounces. At present rates it costs 27 cents to forward a copy of the Journal to a distant zone or to accept a return from a distant zone. By January 1954, the increment cost is expected to be 40 cents. Thus, for example, if for reason of address change, a Journal was forwarded twice, only to be returned to ACSM because of failure to find the member, the three moves would amount to $1.20 under expected rates. It would cost another 40 cents to send the Journal to him when his correct address was finally furnished.

It can readily be seen that it is very important that ACSM have correct addresses at mailing time. The burden of keeping the Congress informed of correct addresses must be the responsibility of each member. Notification of address changes should reach the Executive Secretary by the end of the second month of each quarter.

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ALLEN, Ray C., 16042 Ellsworth St., Detroit 27, Mich.—Surveyor
ANDREWS, John A., Inter-American Geodetic Survey, Apartado 3261, Caracas, Venezuela
AQUINO, Roman R., Bureau of Forestry, Manila, P. I.—Forester

BAIRD, W. J., 22 Linnsmore Cr., Toronto 6, Ontario, Canada—Assistant Inspector of Surveys, Department of Highways
BALLARD, Jack A., U. S. Geological Survey, Denver Federal Center, Bldg. 25, Denver, Colo.—Cartographic Survey Aid
BARKER, Maj. Havelock W., 2299 Winter Park Rd., Orlando, Fla.—Air Photographic and Charting Service
BARNES, Miss Susie A., 2612 Myrtle Ave., N. E., Washington, D. C.—Cartographic Compilation Aid, Army Map Service
BARNES, William E., 322 Capitol Drive, Santa Maria, Calif.—Instrumentman, General Petroleum Corp.
BILL, A. Phillips, 289 Main St., South Deerfield, Mass.—Mathematics Instructor, Deerfield Academy
BLOZIS, John T., 3827 Veazey St., N. W., Washington 16, D. C.—Cartographic Research Analyst, USAF Aeronautical Chart and Information Center
BOND, Charles H., PO Box 1085, Pinedale, Wyo.—Surveyor-Engineer, Seismic Explorations, Inc.
BOPP, Frank W., 10th Rec. Tech. Sq., APO 227, c/o Postmaster, New York—Photogrammetrist, USAF
BOSWELL, David C., Werner Terminal, Ridgefield Park, N. J.—Civil Engineer
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BROTHERTON, Ray J., 501 Onota St., Munising, Mich.—Land Supervisor, Cleveland Cliffs Iron Co.
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CHICKERING, H. G., Jr., 490 E. Broadway, Eugene, Oreg.—Consulting Photogrammetrist
CLEMENT, Donald B., Bureau of Land Management, Washington 25, D. C.—Assistant Chief, Division of Cadastral Engineering
CLERICUZIO, Anthony, 352 Salem St., Woburn, Mass.—Surveyor
CLOONAN, Thomas L., 2611 N. Calvert St., Baltimore 18, Md.—Civil Engineering Aid, Maryland Bureau of Control Surveys and Mapping
CODE, Robert G., 799 Adelaide St., London, Ontario, Canada—Consulting Engineer and Ontario Land Surveyor
COFFMAN, Marshall W., 2705 Yucatan St., Arlington, Va.
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DRAKE, Miles, 302 Scenic Way, Kent, Wash.
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FOX, Joseph A., 409 City Hall, Detroit 26, Mich.
FRASER, Donald J., Room 1000, 245 Market St., San Francisco, Calif.—Associate Design Engineer, Pacific Gas and Electric Co.
FULLER, Arch, 2136 Alki St., Seattle 6, Wash.

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HELLWIG, George W., 6016 Craig St., Springfield, Va.—Partner, Hellwig, Courson and Hellwig
HELMKAMP, A. R., 237 Bridge St., Colusa, Calif.—Partner, California Engineer and Surveying Service
HILLMAN, Conway D., 26 Edgewood Terrace, Millburn, N. J.
HOOD, Maxwell C., 2404 Robbin Rd., Bakersfield, Calif.—Surveyor
HOOK, Robert M., 7628 Santa Monica St., Normandy 21, Mo.—Photogrammetric Engineer
HOWARD, Oliver O., 2653 Bennett Valley Rd., Santa Rosa, Calif.—Surveyor

ISBERG, Clarence E., 537 8th Ave., Fairbanks, Alaska—Airways Engineer, Civil Aeronautics Administration

JARBOE, James A., PO Box 522, Rockport, Tex.—Professional Engineer

KAMBOUR, Theodore, Barton, Vt.
KAUFMAN, Lt. Col. H. Paul, Room 2102, Commerce Bldg., U. S. Coast and Geodetic Survey, Washington, D. C.—Geodetic Mathematician
KEKR, Leslie W., 809 Boyd St., Watertown, N. Y. —Highway Engineer, New York State Dept. of Public Works
KIDDER, Arthur D., PO Box 685, Terre Haute, Ind. —Kidder and Thoma, Consulting Engineers
KING, Thomas B., Box 250, Stephenville, Tex.—Land Surveyor, King Abstract Co.
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LOECHLER, Leon P., 8 E. Broad St., Columbus 15, Ohio—Lawyer
LONG, J. C., Box 387, Goldthwaite, Tex.—County Surveyor, Mills County
LOUREIRO, Ing. Jorge A., Professor, Universidad Nacional del Litoral, Balcarce 1486, Rosario, Republica Argentina
LOVELAND, William P., Box 4, Holtwood, Pa.—Instrumentman, Pennsylvania Water and Power Co.
LUSHENE, Comdr. Joseph P., U. S. Coast and Geodetic Survey, Washington, D. C.—Hydrographic and Geodetic Engineer
LYNCH, Frank T., 216 Pennsylvania Bldg., Wilmington 1, Del.—Civil Engineer and Surveyor, Van Demark & Lynch, Inc.
LYONS, Robert G., Alaska Road Commission, Valdez, Alaska—Engineering Aid, Highway and Construction and Surveying

MANKEY, E. T., 3173 Lake Hollywood Drive, Los Angeles 28, Calif.—Division Engineer, Survey Division, Dept. of County Surveyor
McCOMAS, Howard O., Chief, Cartography Section, Engineer Research and Development Laboratories, Fort Belvoir, Va.
McDUFFEE, James, Seahurst, Wash.
McGREEVY, Wilfrid A., 4937 Rubio Ave., Encino, Calif.—Instrumentman, Los Angeles City Engineering Dept.
McKECHNIE, Clifford B., 3450 Eastham Rd., Dearborn, Mich.—Civil Engineer and Land Surveyor
McLAUGHLIN, Merlin F., Annandale, Va.
McMAHAN, CWO John W., 551st Engineer Base Survey Co., Fort Winfield Scott, Calif.—Survey Officer
MEADOW, Harold M., 1855 Champlost Ave., Philadelphia 41, Pa.—Geophysicist, Shell Oil Co.
MILLER, E. L., 7104 Schley St., Houston, Tex.—Design Engineer, City of Houston
MILLER, Myer, 706 Subway Terminal Bldg., 417 S. Hill St., Los Angeles 13, Calif.—Civil Engineer, Surveyor, Contractor, Real Estate Broker
MOBLEY, T. P., Box 647, Breckenridge, Tex.—Land Surveyor
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MONGNO, Lt. Thomas E., 17 Greymere Rd., Brighton 35, Mass.—U. S. Army Air Force
MOORE, A. B., 307 S. Main St., Pasadena, Tex.—Owner, A. B. Moore Engineering Co.
MORSE, Sam A., PO Box 82, Canadian, Tex.—Land Surveyor
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MUSSER, Harold W., 518 12th St., Marysville, Calif.—Partner, California Engineering and Surveying Service

NEEL, T. D., Box 182, Athens, Ohio—Surveyor, Tennessee Gas Transmission Co.

OGLESBY, Aldrous R., 3449 S. 7th St., Abilene, Tex.—Land Surveyor
O'NON, Pierre J., 438 Manor Rd., Grosse Pointe 36, Mich.—Civil Engineer, Corps of Engineers, U. S. Army
OSTLING, Robert T., Box 102, Roscommon, Mich. —Registered Land Surveyor

PALMERTON, L. M., 320 2nd and Cherry Bldg., Seattle 4, Wash.
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REBITZER, Fred, c/o Cury Manufacturing Co., 447 N. Wood St., Chicago 22, Ill.
REECE, Richard A., 634 Geneva Place, Tampa, Fla. —Cartographer, U. S. Coast and Geodetic Survey
REEVES, Roscoe, 3704 Inverness Drive, North Chevy Chase 15, Md.—Topographic Engineer
REICHEL, David, Hq. Co., 30th Engineers, Fort Scott, Calif.—M/Sgt., Topo. Bn.
RICE, Donald A., 1541 N. Falkland Lane, Silver Spring, Md.—Chief, Section Gravity and Astronomy, U. S. Coast and Geodetic Survey
RICE, Edward E., Rt. 3, Box 36, Houston, Tex. —Senior Engineer, City of Houston
RICHARDSON, David H., 216 Prince Edward Drive, Toronto 18, Ontario, Canada—Surveyor in Charge Field Operations, The Hydro-electric Power Commission of Ontario
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ROCHE, Winston, 11474 Delano St., N. Hollywood, Calif.—Chief of Party, Dept. of Recreation and Parks, Los Angeles
RODY, Martin J., PO Box 461, Chapel Hill, N. C. —Urban Geographer and Research Assistant, University of North Carolina
ROSENBAUM, Hans, 3148 19th St., N. W., Washington 10, D. C.—Translator, Army Map Service

SAILOR, Samuel, 171 Bevier Rd., University Heights, New Brunswick, N. J.—Instructor, Rutgers University
SAMUEL, Cedric B., U. S. Coast and Geodetic Survey, Washington, D. C.—Cartographer
SCHAFFER, Fred, 1340 Randolph St., N. E., Washington, D. C.—Cartographer, U. S. Army Air Force
SCHERMERHORN, Dr. I. W., Lassuslaan, 39, Biltshoven, Netherlands
SERAN, Comdr. Harry A., 240 Wyanoke Drive, San Antonio 9, Tex.—Consulting Geodesist
SERIGHT, John L., Shell Oil Co., PO Box 691, Ventura, Calif.—Supervisor Draftsman
SMITH, Robert L., 5518 6th Ave., Kenosha, Wis. —Surveyor, R. L. Hungerford & Assoc.

STAHL, Clark B., 322 Columbia St., Seattle 4, Wash.
STERLING, Earl F., Rt. 3, Box 584, Mesquite, Tex. —Civil Engineer
STIRNI, A. Richard, 415 Jackson Pl., Alexandria, Va.—Cartographic Engineer, U. S. Coast and Geodetic Survey
STRIEBECK, William H., Jr., PO Box 155, George West, Tex.—Senior Resident Engineer, Texas Highway Dept.
SULLINS, James A., Box 1731, Shreveport, La.—Chief, Drafting Section, Geological Dept., Gulf Refining Co.
SULLIVAN, Edward J., 1443 Albany Ave., Hartford, Conn.—Junior Highway Engineer, State of Connecticut
SULLIVAN, Eugene B., 641 Farmington Ave., Hartford, Conn.—Civil Engineer, Loomis and Sullivan
SULLIVAN, Prof. William F., 7329 Brockley Lane, Houston, Tex.—Asst. Prof., Civil Engineering Dept.

TCHANG, Dr. Te-Lou, 4732 Utopia Parkway, Flushing, L. I., N. Y.
THIBODEAUX, Raymond J., Gaylor Container Corporation, PO Box 528, Bogalusa, La.—Civil Engineer, Land Dept.
THOMPSON, Charles W., 219 S. Grand Ave., Lansing 68, Mich.—Mapping and Graphic Design Engineer, Michigan State Highway Dept.
THOMPSON, George W., 512 W. Kingsmill St., Pampa, Tex.—Surveyor and Civil Engineer
THOMPSON, M. N., 1321 N. Bristol St., Santa Ana, Calif.—Civil Engineer
THOMPSON, Perry, PO Box 1445, Longview, Tex. —Land Surveyor
THRAPP, A. G., 6050 Gloucester St., Los Angeles 22, Calif.— Chainman, General Petroleum Corp.
TOOLE, Samuel P., 2800 Hilltop Drive, Aiken, S. C. —Layout Engineer, E. I. du Pont de Nemours & Co.
TREADWELL, T. K., 5325 Park Rd., S. E., Washington 27, D. C.
TRONOFF, Theodore V., 1976 San Pablo Ave., Berkeley, Calif.—Civil Engineer and Surveyor

VAN BENTHUYSEN, Robert L., 17154 Saticoy St., Van Nuys, Calif.—Draftsman and Computer
VAN ZUYLEN, Johan A., 2733 Jennings Rd., Kensington, Md.—Translator, Army Map Service
VENEZKY, Milton S., 2213 Tecumseh St., Hyattsville, Md.

WALLEY, Roy S., 221 Alvarado Ave., Los Altos, Calif.—Civil Engineer, Public Works Office, 12th Naval District
WALTERS, Maj. Wayne W., 30th Engineer Base Topo. Bn., Ft. Winfield Scott, Calif.—Topographic Engineer
WARDIN, R. W., 1009 W. 20th St., Cedar Falls, Iowa
WATKINS, John S., 417 Allen Ave., Glendale 1, Calif.—Survey Party Chief, Recreation and Park Dept.
WATSON, Philip L., 3918 Lull St., Houston, Tex. —Party Chief, Humble Oil and Refining Co.
WEBSTER, Donald W., 739 N. 2nd St., Milwaukee, Wis.—Civil Engineer and Surveyor, H. C. Webster and Son
WEIR, Virginia A. L., 465 Oakwood St., S. E., Washington 20, D. C.
WELCH, Harold J., 1530 Carr St., PO Box 7786, Denver 15, Colo.—General Manager, Universal Engineering, Inc.
WERLINE, Wilbur A., U. S. Coast and Geodetic Survey, Washington, D. C.—Cartographic Aid
WHITE, Jay R., 201 N. Hooker Ave., Three Rivers, Mich.—St. Joseph County Surveyor
WILCOX, Charles W., 419 Pioneer Drive, Glendale 3, Calif.—Surveyor, Recreation and Park Dept., City of Los Angeles
WILLIAMS, Paul A., 322 Columbia St., Seattle 4, Wash.
WILLUMSEN, O. S., 2206 Boylston Ave., N., Seattle 2, Wash.
WILSON, Jesse E., Court House, Road Master Office, The Dalles, Oreg.—Field Engineer, Wasco County Road Dept.
WILSON, Perry E., 218 N. Pineapple Ave., Sarasota, Fla.—Land Surveyor
WOOD, Harrison D., PO Box 425, Price, Tex.— Production Dept., The Ohio Oil Co.
WOODSON, H. L., Jr., 4970 35th St., N., Arlington 7, Va.
WOOLLEY, Glen B., 1174 S. 9th St., East, Salt Lake City, Utah
WOOLLEY, Harold L., Pafford, Jones & White, 5328 Hollywood Blvd., Hollywood 27, Calif.
WOPAT, Victor H., U. S. Geological Survey, PO Box 346, Sacramento, Calif.
WORSLEY, Clarence T., 4080 Elmwood Court, Riverside, Calif.—Chief Deputy County Surveyor
WRIGHT, Marshall S., Jr., c/o Jack Ammann Photogrammetric Engineers, Broadway and Tenth Sts., San Antonio, Tex.—Engineering Consultant

TV Scans Ocean Floor

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Underwater television, which escapes many limitations of human divers, already has been used in England and in the United States. Scientists employed underwater video in 1947 to evaluate results of the Bikini atom bomb tests. It was used in England in the search for the sunken HMS *Affray*.

The new television cameras are to be housed in watertight casings capable of sinking to depths of 1,000 feet. A lighting system attached to a stabilizing fin outside the casing will illuminate the 70-degree field of vision provided by the cameras' wide-angle lenses.

Remote facilities will permit shipboard viewers to change lenses for close-up pictures, to adjust the aperture to let in the proper amount of light, and to focus the camera. Shipboard screens will be linked to the underwater cameras by a complex, multicore cable which will transmit the camera's electronic signals.

Television cameras can work at greater depths and for longer periods of time than can divers, and no risk of life is involved. They can be maneuvered easily. Since they present pictures to shipboard viewers, less accurate verbal descriptions are eliminated.—*Science News Letter*, June 28, 1952.

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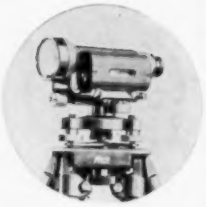

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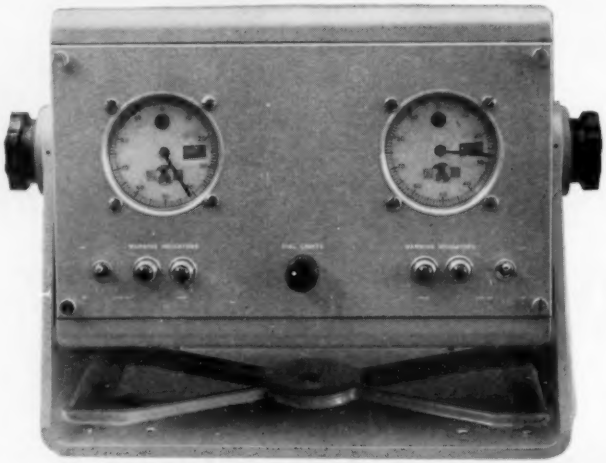

LORAC Type "A" Position Indicator Unit

Radio Surveying and Navigation System

The Position Indicator illustrated above is part of the LORAC receiver shipboard installation. Its dials display at all times readings which indicate the exact position of the ship.

Three land-based transmitter stations emit continuous radio waves of medium frequency establishing a standing wave pattern which covers several thousand square miles. Any number of LORAC receivers may be operated within the coverage area.

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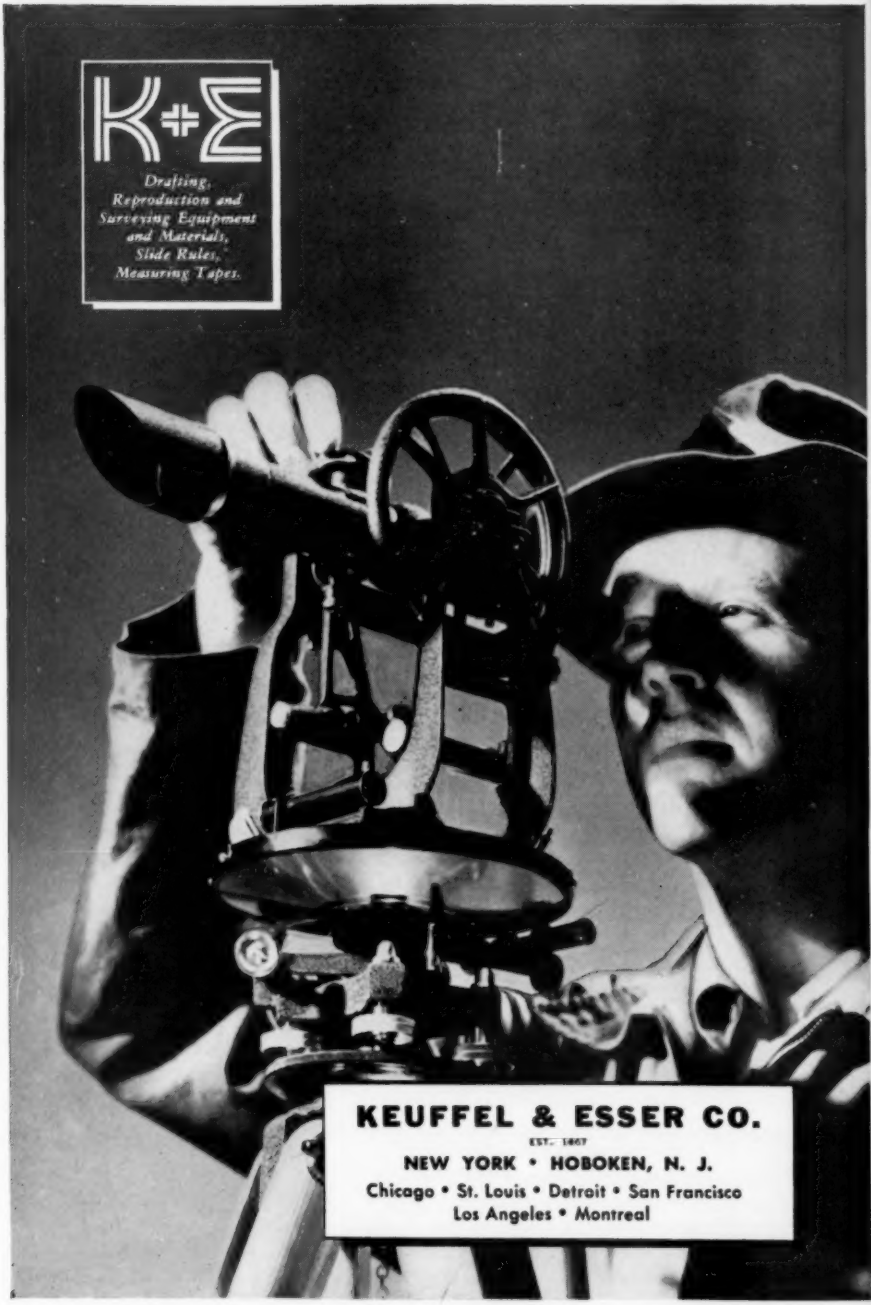
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